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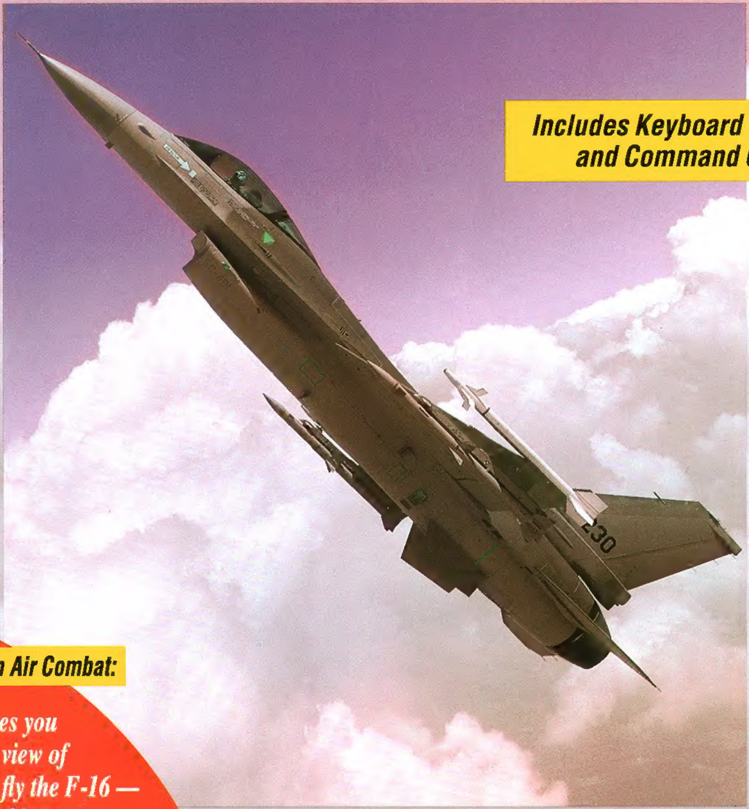
FALCON 3.0

AIR COMBAT



Includes Keyboard Template and Command Cards

Acclaim for *Falcon Air Combat:*

"Pete really gives you a fighter pilot's view of what it's like to fly the F-16 — and that's something no one else writing in this area can do."
– **Gilman G. Louie,**
CEO, Spectrum-Holobyte, Sphere, Inc.,
Designer of Falcon 3.0

Pete Bonanni
Fighter Pilot

and Bernard Yee

FALCON 3.0 AIR COMBAT

Pete Bonanni
Bernard Yee

Silicon Valley

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2600 Tenth Street
Berkeley, California 94710
U.S.A.

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Falcon 3.0 Air Combat

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234567890 DOC 998765432

ISBN 0-07-881701-3

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Acknowledgments

I would like to thank a number of people for helping this book take shape: Shay Addams for leading me into this; the many folks at Osborne who gave me a chance to pull this off; and the folks at Spectrum HoloByte who were always helpful, even though they had their own manual to finish (Marisa Ong, Tom Byron, Steve Blankenship, and many others).

Thanks especially to our contributing writer, Mike Weksler, who took most of the screen captures you see in this book, filled out many of the technical details, and made sure that the appendixes would be really worthwhile. (Mike and I were competing throughout the writing of this book to see who could pull off the most consecutive all-nighters. I'm not sure who won.) Thanks also to Tom "KC" Basham for his contributions to Chapter 8 regarding campaign management.

Thanks to Ivan Luk, who provided the terrific command cards and keyboard templates you'll find at the back of this book and helped out tremendously with the Communications appendix. I'd also like to thank the folks at Creative Labs, ATI, and Insight Computers who gave me one helluva system on which to play Falcon 3.0.

And a big thank you to the people who helped us to track down the photos in Chapters 1 and 2: Chuck Porter at the Department of Defense; Owen Darcey, who nailed some great photos in the Smithsonian Institution's archives; Ray Wagner, who put us in touch with William T. Larkins, who put us in touch with Owen Darcey, who saved the day; the United States Air Force; and Langley Air Force Base.

Most of all, I'd like to thank Stefanie Smith for being patient with me as I stayed up late nights stalking bandits and writing chapters. Also, my very special gratitude and respect go out to my parents, Richard and Amy, who gave a little kid a TRS-80 4K Level I computer on Christmas day many years ago and have supported everything (well, almost everything) that kid has ever done.

—Bernard Yee

Introduction

In the last few years, simulated flight on personal computers has soared to incredible heights in technology. Faster processors and more efficient programs have given us solid-seeming, detailed terrain to fly over; onboard systems such as targeting radar are modeled to exacting degrees; and the defeat of simulated enemy aircraft requires actual air combat maneuvers.

As more systems and features are implemented within a simulation of a modern fighter aircraft, the size and complexity of the simulation increases proportionally. Falcon 3.0 is such a simulation and, for the uninitiated, its depth and complexity make it the most challenging product in its genre to learn, let alone master. This book will bring the world of the F-16 fighter pilot closer to you, the Falcon 3.0 pilot.

About This Book

Chapters 1 and **2** give you a historical perspective of air combat, including the development of the F-16.

Chapter 3 is to the Falcon 3.0 simulation what flight school is to a rookie pilot. You learn about aerodynamics, flight fundamentals, cockpit instruments, and the HUD (Heads Up Display). The chapter concludes with your first checkout (orientation) flight in the F-16. You strap in and take off, fly basic maneuvers, navigate, and land.

In **Chapter 4**, you learn the role of the F-16 as a versatile weapons platform. This chapter introduces air-to-air and air-to-ground combat, describes the various air-to-air and air-to-ground ordnance in the Falcon 3.0 simulation, and discusses weapons employment parameters.

In **Chapter 5**, the various radar and HUD modes are explained. You learn to translate the vital information displayed on your radar screen, HUD, and Threat Warning Indicator into meaningful information that will make the difference between being the hunter and the hunted. In addition, you learn about intercept geometry and the phases of an intercept.

Since people first climbed into frail, fabric-covered aircraft and engaged in the first aerial duels, to the aerial armada of Desert Storm, fighter pilots have had one common goal–to vanquish aerial foes. **Chapter 6** covers basic fighter maneuvers and teaches you how to fly your F-16 effectively when engaged by the enemy in a dogfight.

Chapter 7 covers air-to-ground ordnance in detail. You learn how to defeat the enemy on the ground from above. How do you know what weapons will work on SAM sites, a bridge, or a nuclear reactor? Read Chapter 7.

In **Chapter 8**, you learn how to apply all of the lessons learned in previous chapters to combat in a simulated war. You are assigned to an F-16 squadron as squadron commander and given a mission briefing. You plan the mission by assigning flights of friendly aircraft and setting up strike flights, Combat Air Patrols, escort flights, and more. You also learn about combat formations and wingman tactics. The chapter concludes with a walkthrough of a typical campaign.

Appendix A tells you how to run Falcon 3.0 on your computer. All the features of Falcon 3.0 are useless if you can't install the software on your computer. You'll learn how to configure your system to run Falcon 3.0 and how to run Falcon 3.0 with the QEMM, NETROOM, and 386Max expanded memory managers. If you can't quite squeeze the mandatory 600K of RAM out of your system to fire up Falcon 3.0, read this appendix.

Appendix B covers Red Flag and ACMI. Red Flag is the mission editor in Falcon 3.0. It allows you to create missions to your specifications. The ACMI (Air Combat Maneuvering Instrumentation) is modeled after the system utilized in the real Red Flag exercises. Falcon 3.0 allows you to record airborne videotapes of your missions for later replay in the ACMI system.

In **Appendix C**, you learn how to fly against human opponents in duel or multi-player dogfights via a modem, a null modem, and a network. In addition, Falcon 3.0 allows you to fly with one or many human pilots in cooperative missions.

Fly a Combat Air Patrol against computer-generated adversaries while your buddy flies a strike mission, or take him on in an all-out dogfight–its all here.

Real F-16 pilots don't use a keyboard to interface with their jets, and you don't have to either. **Appendix D** tells you how to use the Thrustmaster Inc. Weapon Control System (throttle device) and Flight Control System (joystick).

Appendix E is a glossary. It includes technical terms and some of the more colorful terms in the fighter pilot vernacular.

Appendix F provides you with insight into the inner workings of the Falcon 3.0 software itself.

Keyboard Templates

Keyboard templates are included at the end of this book; you can tear them out and place them on your keyboard for reference. Also included is a command summary card that covers even undocumented Falcon 3.0 keyboard commands.

Icons Used in This Book

Various icons appear in this book to serve as visual cues. Following is a list of the icons and what they mean:

This icon indicates that you should try the computer exercise in the text. If there is a lesson number under the icon, load that lesson from Falcon 3.0.

This marks a list of mission profiles and mission objectives. Think of these as directives from your commanding officer.

This icon denotes background information, strategies, or technical information about flying or fighting.

This marks a special note, tip, or other important information about flying or fighting.

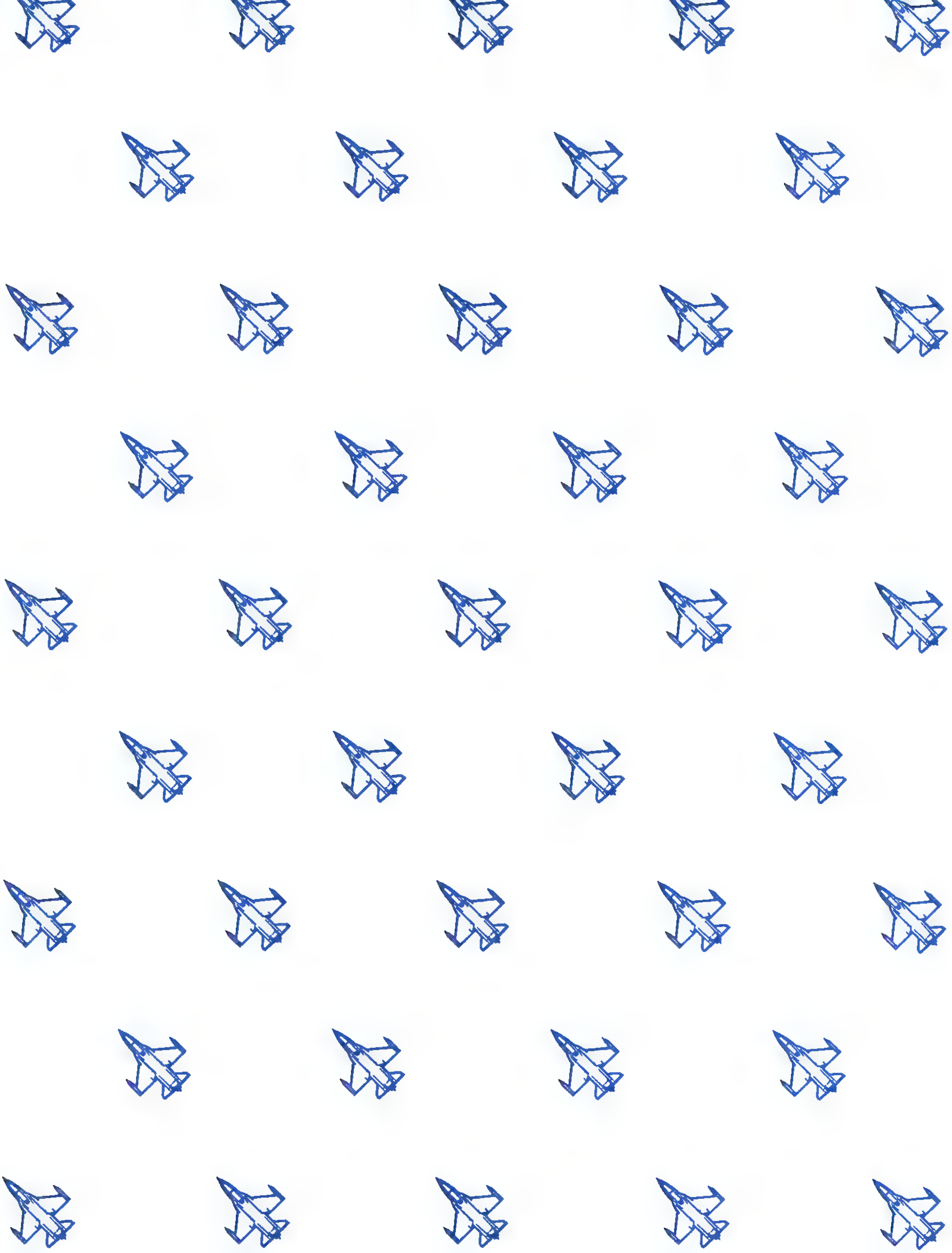
This marks a bit of aviation trivia.

This marks an air combat story; these will be old war stories some day.

Author's Note

Falcon 3.0 gives you an idea of the incredible complexity and danger of being an air combat pilot. Remember as you fly that it may sometimes be necessary to take lives–lots of them–to defend what you cherish. I only hope that one day a simulation like Falcon 3.0 will be sheer escapism rather than a powerful reminder that we carry vast instruments of destruction that are easy to set in motion, but difficult to stop.

–Bernard Yee



CHAPTER

1

AIR POWER IN THE MODERN AGE

"Success flourishes only in perseverance—ceaseless, restless perseverance."

—Baron Manfred von Richtofen/Leading Ace of WW-1
German Air Service, 80 Victories

The first Falcon simulation opened up a dynamic virtual world of single-ship air combat. It created a realistic and complex world that set a standard in PC-based flight simulation that other software makers still try to imitate. As an F-16 pilot I (Pete Bonanni) was surprised by the accuracy of the software. It was so realistic I wondered how anybody but a trained fighter pilot could use the simulation.

Of course thousands of people did figure out Falcon despite its complexity. Falcon Air Combat users learned how to decipher the radar and HUD displays of the F-16 and to employ the aircraft in both air-to-air and air-to-ground mission scenarios, and in so doing, gained rare insight into how today's fighter aircraft is piloted. For the successful practitioners of Falcon Air Combat, this new version lets you fly a little further into the fighter pilot's world. Falcon 3.0 is currently the state-of-the art fighter simulation.

Falcon 3.0 adds another dimension to the air combat environment with the introduction of multi-ship squadron employment and air campaign strategies. Much of the software for Falcon 3.0 is based on a simulation used by the U.S. government for actual F-16 training. Just as in the first Falcon simulation, the creators of Falcon 3.0 placed a high premium on realism.

Realism is both an opportunity and an obstacle in Falcon 3.0. The opportunity is that the pilot can use Falcon 3.0 to see and understand a broad spectrum of modern air warfare. The obstacle is that in order to accomplish this objective you must enter a virtual reality that is highly complex and dynamic because it follows the actual laws of physics and aerodynamics that the Falcon aircraft does.

You must acquire some academic knowledge and tactical perspective to overcome the "complexity" obstacle created by Falcon 3.0 but your effort is paid off. Falcon 3.0 places high demands on the pilot but will also set a new course for flight simulation by providing an on-going military campaign where your performance affects the entire war effort.

This chapter and the next will expand your academic knowledge of air warfare to help you build a tactical perspective of air combat. This will provide a basis from which to discuss air campaign strategies in later chapters of this book. This chapter will take a broad look at air power and how it was used in the period from World War II through Vietnam.

Air Power Comes of Age

Throughout the early twentieth century, the prophets of air power predicted that air armadas would shape the outcome of future wars. Men such as Billy Mitchell and Giulio Douhet expanded the theories of air power and predicted that the clash of aircraft would decide victory or defeat, long before ground and naval forces could engage. In the decades following these predictions, air power did evolve to play a central role in the major conflicts of modern armies in the post-World War I period. Air power, however, was used in most cases as a complementary combat arm to support the traditional ground- and sea-based forces. The Battle of Britain in World War II was the first in which air power as a stand-alone force determined victory.

The Battle of Britain consisted of a series of daily and nightly air battles that raged for several weeks in the skies over Great Britain in late summer of 1940. The German Luftwaffe tried to wrest control of the skies over the English

Channel from the British. The Germans' air superiority gave them enough confidence to attempt Operation Sea Lion, the invasion of Great Britain by the German Army; however, the British RAF (Royal Air Force) fought under favorable geographical and technical conditions and won the battle. The RAF victory saved Britain from invasion by the German army and proved air power alone could defend an island nation from invasion.

Conversely, the German offensive air campaign failed. Air power had yet to prove that it could stand alone as an offensive force. This would soon change.

Strategic Bombing

After the Battle of Britain the United States entered the war, and Allied bomber forces started to carry out a protracted nonstop bombing campaign against Germany. This campaign consisted of strategic bombing aimed primarily at war-related manufacturing and the civil infrastructure (power stations,

Figure 1-1.

The B-17, one of the first true bombers

communication facilities, and transportation). Figure 1-1 shows a B-17, one of the primary bombers used to carry out this campaign.

In 1908, Douhet predicted that great bombers would engage the enemy and win wars without any need for land armies. The Allied bombing of Germany was the first real test of Douhet's theories. Because the English Channel separated German and Allied armies, this was a perfect place to test offensive air power. For a full year prior to the invasion of Normandy in June of 1944, the Allies bombed German-held territory. The impact of this air battle is still being debated by historians but the one clear result was that the Allies did achieve air superiority over the English Channel and the beaches of Normandy, which enabled their successful invasion of Europe. Air power may not have lived up to all of the predictions of men like Douhet, but it was clearly effective in the skies over Germany. Of course, indiscriminate bombing also leveled the city of Dresden, which brought no strategic gain to the Allies whatsoever. The cultural and artistic, not to mention human, losses are still discussed today.

On the other side of the world another U.S. strategic bombing campaign was taking place against the Japanese. This campaign would prove the true value of air power. Despite the success of the Allied attacks on Germany, it became clear early in the strategic bombing campaign that a ground invasion of France would be required to win the war. Against the Japanese, however, the U.S. Joint Chiefs of Staff considered the possibility that victory could be achieved by strategic bombing combined with a naval blockade.

There were several significant challenges to this strategy. The distances involved in this theater made a sustained bombing campaign in the Pacific difficult. In addition, the U.S. did not have a bomber with sufficient range to reach the Japanese islands from U.S.-held territory. These obstacles were eventually breached by U.S. victories in an island-hopping naval strategy that closed the distance to Japan, and by the introduction of the B-29, shown in Figure 1-2. This bomber

The Boeing B-17 Flying Fortress was first used in combat on 8 July 1941, on a daylight raid. A derivation of the B-17 was to become the first airliner with a pressurized cabin.

could carry twice the bomb load of a B-17 and could fly over 4,000 miles without refueling–twice as far as the B-17. With the introduction of the B-29 and the capture of the Marinas Islands in October of 1944, the strategic bombing of Japan began in earnest.

1800 Degrees in the Shade

The tactics used at the start of the B-29 bombing of Japan were essentially the same as those used in the U.S. bombing of Europe: high altitude, daylight precision bombing with high-explosive weapons. The B-29s flew their missions at 30,000 feet, about 8,000 feet higher than B-17s and B-24s. This additional altitude made it harder for the ground defenses to shoot down the B-29s but resulted in miserable bombing accuracy. At 30,000 feet the jet stream causes severe aircraft drift, which played havoc with the B-29's Norden bomb site. In addition, the weather, always a factor in visual bombing,

Figure 1-2.

The B-29 could fly twice as far as the B-17

became an even bigger problem as the altitude increased. After multiple failures with high-altitude bombing, General Curtis LeMay, the commander of the Pacific bomber force, changed the whole tactical approach to bombing the Japanese industrial base.

General LeMay noted that earlier in the war the Japanese had firebombed several Chinese cities with devastating effect, since these cities were built primarily of wood and burned very easily. In addition, the main industrial targets were located in the heart of these cities with a large percentage of manufacturing being done in small shops located in urban areas. LeMay considered the failure of the high-altitude precision bombing campaigns and agonized for weeks over firebombing urban areas in Japan. He finally came to the conclusion that if he could end the war quickly with strategic bombing, more lives could be saved on both sides. In what would become one of the boldest decisions ever made in the annals of air warfare, General LeMay ordered a daring low-altitude B-29 firebomb attack on Tokyo.

General LeMay implemented these changes for this attack:

- The B-29 attack would take place at night instead of day.
- The altitude of the attack would be 5,000 to 8,000 feet instead of 30,000 feet.
- Firebombs would be used instead of high explosives.
- All protective guns and ammunition except for the tail gun would be removed to improve the bomb load and range.
- The bombers would attack the target single-ship rather than in massed formations.

The attack was launched on 9 March 1945 and was led by pathfinder B-29s. The pathfinders marked Tokyo with a giant "X" pattern of firebombs that allowed the rest of the

A total of 88 B-29 Superfortresses were dispatched by the USAF's 21st Bomber Command on 24 November 1944. This was the first major air attack on Tokyo.

bomber force to zero on target. The attack hit the people of Tokyo with a violence never before experienced. The temperature in the fire-ravaged streets reached 1800 degrees Fahrenheit and over 16 square miles of the city were burned to the ground. Reconnaissance photos taken on 10 and 11 March revealed that over 22 strategic industrial targets had been completely destroyed.

After quickly assessing the impact of this attack, further attacks on other industrial cities were ordered with the same results. Nagoya, the center of Japanese aircraft manufacturing, was bombed on 11 and 19 March. Osaka, Japan's second largest city, was bombed on 13 March, and Kobe, another large Japanese city, was bombed on 16 March. From the 8th to the 19th of March, 32 square miles of urban area were destroyed by LeMay's firebombing B-29s.

Japan's ability to manufacture war materiel was destroyed by this onslaught. Still the Japanese government decided to fight on. The strategic bombing had destroyed their industry and civil infrastructure but the Japanese government would not negotiate. They knew that an invasion of the Japanese islands would inflict heavy casualties on the invading U.S. Army. In the wake of these casualties they calculated that they could negotiate from a position of strength for a favorable peace treaty. They were wrong. On 6 August 1945 the world's first atom bomb was dropped from a B-29 on Hiroshima, changing Japan and the rest of the world forever. The bomb forced the Japanese government to consider surrendering but before they could act, another atomic bomb fell on Nagasaki on 9 August 1945. The atom bombs used on these two cities produced temperatures of 50 million degrees Centigrade at the center of the blast.

These two attacks had a predictable result on the Japanese leadership. They realized that the U.S. would not be forced into a land invasion of the main islands. They could simply continue to rain down single bombs with enough destructive power to destroy an entire city. The war was over. Japan surrendered unconditionally on 2 September 1945. The

United States, of course, has the sad distinction of being the only nation to use nuclear weapons in an offensive manner.

Air power had been triumphant in the Pacific theater but not without unleashing nuclear war. Bombing the Japanese was more effective than bombing the Germans because the Japanese defenses were lighter and Japanese cities were built of more flammable material. Conventional attacks on Japan proved to be highly successful but probably would not have brought about an end to the war. Still, air power achieved virtually all the success originally envisioned by Mitchell and Douhet. Victory had been secured from the air without the need for a large-scale land invasion.

Tactical Air Power

Air power was also used very successfully in World War II in other important roles beside the strategic air campaigns. Aircraft like the P-47 Thunderbolt, shown in Figure 1-3, were employed tactically to support ground forces. Fighters such as the P-47 had a great impact on the war because they could attack enemy troops in depth far beyond the range of artillery. Fighters were also used to shoot down enemy aircraft and ensure that Allied forces were not subject to the same kinds of attack from the air.

More than 15,000 of the Republic P-47 Thunderbolts were built during World War II. The P-47 made its first appearance as a prototype named XP-47B.

In tactical roles such as gaining air superiority and supporting ground forces, aircraft proved to be a critical component of World War II armed forces. Generally, fighters were used for tactical missions in and around the battlefield and bombers were used for strategic missions deep in enemy territory. The difference between tactical and strategic bombing, however, lies in the targets attacked and not the aircraft used.

Strategic targets generally consist of enemy industry and civil infrastructure that support the enemy war effort. *Tactical targets* are generally those targets that are close to the battlefield that involve the enemy army involved in the war effort. These targets normally include vehicles, troop concentrations, lines of communications (bridges and roads), and runways.

Figure 1-3.

The P-47 Thunderbolt

The evolution of tactical air power into an integral part of a combined arms team began in World War II, and continues to this day. Fighters were employed in close coordination with ground forces in World War II. Bombers were rarely used in this manner and were instead used for strategic purposes, independent of the ground campaign. This split in the use of air power turned out to be highly successful during the war. A massive strategic effort was waged to destroy the war-making capability of the enemy while tactical air power was being used to gain air superiority and directly support the army in the field. Strategic air power was used as envisioned by Douhet, to fight the enemy deep and away from the ground armies while tactical air power was used in conjunction with ground forces.

The Constraints of Air Power

For all of the success that air power demonstrated in World War II there were still some severe technical limitations of combat aircraft at this time. The ability to destroy a target from the air is driven by two components: *accuracy* or the probability of hitting the target and *lethality* or the destructive power of your munitions. Further, there are two general categories of targets: *point targets* such as tanks and bridges and *area targets* such a petrol storage and troop concentrations.

While World War II aircraft were limited in both accuracy and lethality, accuracy was their primary shortcoming. Most of the offensive air campaigns of World War II were carried out from high altitudes, which limited the accuracy of the attacks. Because bombers (including fighter bombers) did not carry very large payloads, and given that these payloads were not very accurately delivered, the effects of air power were in turn limited. Destroying a point target such as a major steel bridge required dozens of aircraft dropping hundreds of bombs. Area targets such as large factory complexes and railroad marshalling yards were much more vulnerable to attack but these targets required even more bombs to destroy. Air forces during the war consisted of thousands of aircraft but there were millions of point and area targets—far too many for aircraft alone to cover.

This is not to say that air power was not effective during World War II. Air power had prevented the German army from invading Great Britain and had severely crippled the industrial output of both Germany and Japan. But it does point out why strategic bombardment was necessary and why urban areas had to be firebombed in order to destroy a handful of strategic targets. This policy stemmed from the inaccuracy of offensive aircraft.

Limited War

Technical constraints were one limitation of air power. During the war in Korea another handicap emerged that would distort the nation's perception of air power for a generation. This handicap was the political policies of limited war. *Limited war* is a war fought with only marginal levels of effort for well-defined objectives. This means simply that each side is limited in how, where, and which arms can be used. Limited war was a product of the Cold War between the U.S. and the U.S.S.R. Since both superpowers possessed nuclear weapons, an all-out war between the Communists and the "Free" World was correctly deemed suicidal.

One of the problems with limited war was that it was virtually impossible to determine just how much force was enough to achieve your objectives. If you stepped out of bounds in a conflict, you risked bringing about a confrontation with the other superpower. A direct fight between the superpowers risked Armageddon. If you did not use enough force then you risked being defeated. The Korean War was the first limited war fought in the shadow of superpower nuclear weapons.

The Korean War

On 25 June 1950 the North Korean army launched an attack across the 38th parallel into South Korea. U.S. forces, under the command of General Douglas MacArthur, countered with air and naval forces. General MacArthur was soon given permission to use the U.S. Army, and a bitter ground war in Korea began.

General Emmett O'Donnell at this time commanded the Far East Air Force (FEAF) Bomber Command and immediately advised the overall commander of the FEAF, General George E. Stratomeyer, to launch a B-29 incendiary bombing raid against North Korean cities. His plan for an all-out strategic bombing campaign was immediately rejected by Stratomeyer because of political and diplomatic reasons. President Truman wanted the war limited to the Korean peninsula and warned the military to use extreme caution during the conduct of the war. Truman later wrote:

Boeing B-29 Superfortresses entered the Korean War on 27 June 1950, when the USAF's 19th Bombardment Group destroyed railroad lines and bridges around Seoul.

> "Every decision I made in the Korean conflict had this one aim in mind: to prevent a third world war and the terrible destruction it would bring to the civilized

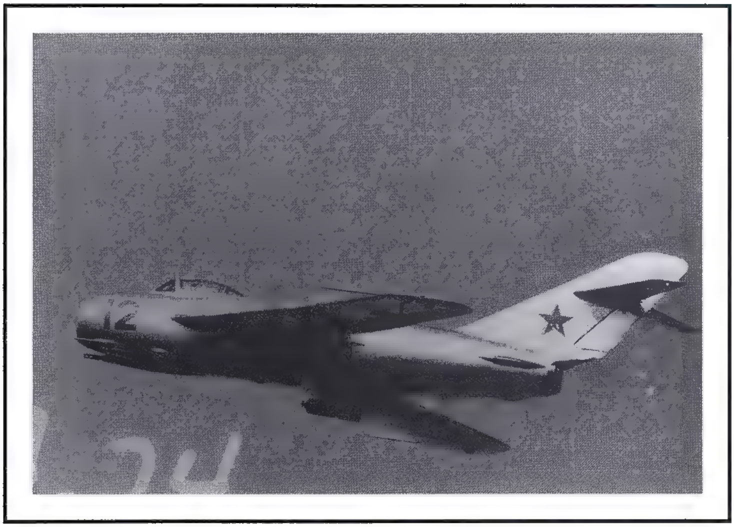
> world. This means that we should not do anything that would provide the excuse to the Soviets and plunge the free nations into full-scale, all-out war."

The Korean War was the first limited war, and the use of air power had several constraints that did not apply in World War II. The first of these was the concept of limited geographical boundaries that created enemy sanctuaries. The North Koreans took advantage of this limited war constraint on U.S. air power and moved their aircraft, such as the Soviet-built MiG-15 shown in Figure 1-4, north into China to avoid attack.

Another limitation on air power was the targets available inside the geographic boundaries. For example, North Korean hydroelectric facilities could not be attacked in the first two years of the war. Along with limited targets, U.S. air power could not employ incendiary bombs. The use of air power in

Figure 1-4.

The Soviet-built MiG-15



the early stages of the war was limited by political considerations to tactical employment.

Strategic Air Power in the Korean War

B-29s were committed to bombing early in the war as United Nations Forces were pushed back to a 50-mile perimeter on the southern Korean coastal city of Pusan. The bombers, however, were extremely limited in the targets they could attack and were primarily used for tactical missions. Troop concentrations were their main targets, and they did an adequate job bombing these targets but this was not a determining factor in the outcome of the war. As the war continued, some strategic targets were bombed but these targets were carefully selected. Finally in June of 1952, with the one-year-old peace talks bogged down, the United States unleashed the B-29s. The first targets hit were four North Korean power plants, which plunged the North into darkness and brought their power-dependent manufacturing to a halt. The North Koreans still did not seriously negotiate, so the U.S. Air Force was given permission to attack the North Korean irrigation and dam system. Four key dams were destroyed in the strategic bombing campaign, flooding the crops and ruining the agriculture output of North Korea. Predictably the North Koreans signed an armistice on 26 July 1953.

Korea was the first limited war and the lessons learned were obvious. The full application of even conventional air power would be constrained in future wars involving the superpowers. The use of air power in the last year of the Korean War was very similar to the use of air power in World War II. In the last full year of the war a strategic bombing campaign was carried out against the North Koreans that resulted in great devastation to the North, but also ended the war. The Korean War brought no significant gains in air power accuracy or lethality. Because of this, the heavy bomber was still needed to destroy most strategic targets. The only thing that really changed in air warfare between World War II and the Korean War was that air power had become shackled by the chains of limited war "rules of engagement."

The Vietnam War

The limited war in Vietnam proved to be an even bigger challenge for air power planners than the Korean War. U.S. involvement in the war began slowly with a strategy of "measured response" or "gradual escalation." This strategy called for a gradual expansion of the war in response to the actions of the enemy. This counterpunching plan was intended to show a "reasonable enemy" that you could always use more force. The enemy could never bring sufficient force to bear on the fight to actually win because you would keep matching their efforts until you eventually wore down the enemy with your superior power.

Of course with the benefit of hindsight we now know that this strategy is clearly worthless. In fact it is worse than worthless–it is dangerous and produces some very distorted views on the use and effectiveness of military power, and may even lead to tremendous waste of life on both sides.

Vietnam was another war fought in the shadow of superpower nuclear weapons. Gradual escalation was very similar to the strategy used to limit the Korean War. The difference between the air war in Korea and the air war in Vietnam is that in Vietnam, the intensity of air power was turned down still another notch. In Vietnam, amid the violence and chaos of war, air power was carefully applied in measured amounts in order to bring about precise political and military results. Politicians had taken control of the civilian leadership of the military and overruled common sense. Operation Rolling Thunder was the first act in the tragi-comedy that became the air war in Vietnam.

Operation Rolling Thunder

Rolling Thunder was the 1965-1968 campaign to bomb North Vietnam. The military objective of Rolling Thunder was to disrupt the flow of military supplies going from North to South. The political objective was to pressure the North Vietnamese leadership to end the war. Rolling Thunder was a strategic campaign flown by fighters. The F-105, shown in

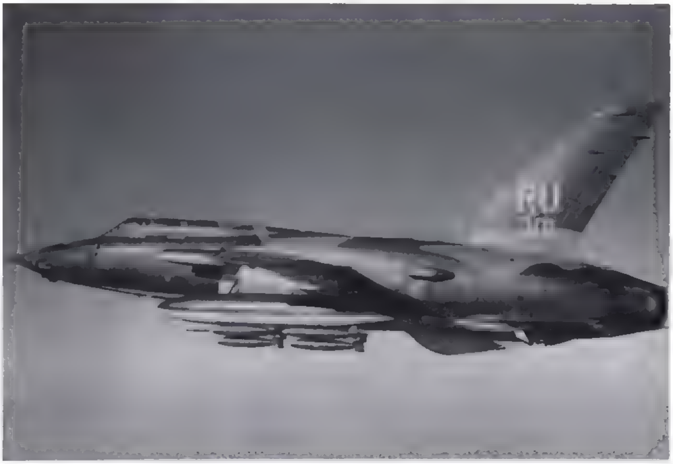


Figure 1-5.

The F-105, the primary fighter used in Rolling Thunder

Figure 1-5, was the primary fighter used during Rolling Thunder to bomb North Vietnam.

The F-105 was a supersonic fighter-bomber and a mid-1960s state-of-the-art bombing platform. Unfortunately state-of-the-art did not mean a big increase in accuracy or lethality. The F-105 could bomb only marginally better than the fighters and bombers of the Korean War. It could carry more bombs, however, and this somewhat made up for its relatively inaccurate bombing system. At this time the U.S. Air Force had powerful B-52 bombers, shown in Figure 1-6, available for strategic bombing but the decision was made to keep the B-52s in South Vietnam so as not to escalate the war. The B-52 was no more accurate than the F-105 but it could carry roughly ten times the bombing load.

The definitive F-105 was the F-105D, which could operate in all weather and attained speeds in excess of Mach 2.

Rolling Thunder started in 1965 and gradually escalated in intensity as the U.S. strived to bring the North Vietnamese

Figure 1-6.

The B-52 bomber

to the peace table. Finally the North Vietnamese agreed to negotiate peace and the talks began in March of 1968. At the peace conference the North Vietnamese stated that serious discussions would not take place while the bombing of North Vietnam continued. President Johnson ordered a halt in the bombing of North Vietnam in October of 1968 in order to spur the peace talks forward. Of course this had just the opposite effect. The halt in the bombing gave the North Vietnamese even more confidence in their ability to drag on the war and weaken the political will of the United States.

A B-52 bomber dropped the world's premier air-transportable hydrogen bomb on 21 May 1956. Its target was Bikini Atoll in the Pacific Ocean.

Operation Linebacker I

The peace talks did drag on. In fact they dragged on for several bloody years as U.S. air power stayed corralled in South Vietnam. Things changed on Good Friday, 30 March 1972. On this date the true intentions of the Communists were exposed as three North Vietnamese infantry divisions, backed up by tanks and artillery, struck south across the Demilitarized Zone (DMZ) into South Vietnam. Within seven days of this attack, the assault had expanded to include a total of 12 North Vietnamese divisions. The North Vietnamese had used the halt in the Rolling Thunder bombing to mass troops and prepare for this invasion of South Vietnam.

The reaction of the U.S. was swift. On 2 April the U.S. military was given authorization to resume the bombing of North Vietnam. This campaign to bomb the North would later be called Linebacker I. Linebacker I had similar military objectives as Rolling Thunder: disrupt the flow of military supplies to the South. This time, however, the North Vietnamese had a regular army in the field rather than a guerrilla army. Bombing the supply lines of a regular army, with all of its fuel hungry tanks and vehicles, made the bombing campaign much more effective. In addition, the very tightly controlled list of authorized targets was expanded.

Rolling Thunder allowed approximately 60 authorized targets in and around the Hanoi/Haiphong area. Each target had to be approved by the White House, and authority to attack it only lasted for a short prescribed time period. If the mission got scrubbed due to bad weather, military leaders had no authority to shift to a new target.

The first combat operation flown by the B-52 Superfortress in the Vietnamese War was on 18 June 1965. The bombers were used to attack Viet-Cong with HE bombs.

In the Linebacker I campaign, the target list not only grew to over 100 targets, but operational commanders also had a greater flexibility in hitting these targets. Control of the time period for hitting the expanded list of targets was given to the operational commander, which greatly increased the flexibility of air power in the theater. Furthermore, the U.S. Air Force started to send B-52 bombers after selected targets in North Vietnam.

While Linebacker I was a more intense bombing effort than Rolling Thunder, with expanded targets and aircraft, the effectiveness of the campaign was further enhanced by introduction of a new technology: precision-guided munitions. The reason that big bombers were so important in the air wars to date was that large numbers of bombs tended to make up for accuracy problems. The precision-guided bombs changed this fundamental "bigger is better" air power dictum. With a precision-guided bomb, a fighter could drop a single weapon and guide it with a laser or other means to within a few feet of the desired impact point on the target.

An example of the impact that these weapons had on the war could be seen in the attack on the Thanh Hoa bridge in North Vietnam. During Rolling Thunder the U.S. flew hundreds of sorties against the bridge and lost dozens of aircraft without stopping traffic on the bridge. During Linebacker I, on 10 June 1972, a dozen F-4 Phantoms used laser-guided bombs (LGBs) to finally drop the bridge into the river and deny the North Vietnamese the use of this important river crossing. LGBs were not deployed in large numbers at this time, but they did make a large contribution to the success of the Linebacker campaign.

Other improvements in aircraft bombing accuracy were also introduced during Linebacker I. The A-7 Corsair, shown in Figure 1-7, flown by both the Navy and Air Force, was fitted with a advanced computer bombing system that could consistently drop bombs in wartime conditions within 100 feet of the target. This accuracy is two orders of magnitude better than an F-105, which could only consistently drop bombs 200 to 300 feet from the target.

Linebacker I was a very effective strategic bombing campaign and stalled the North Vietnamese offensive in South Vietnam. In October of 1972, the North Vietnamese sued for peace. The Linebacker I operation did not stop this time and when the North Vietnamese walked out of the Paris peace talks and rejected peace terms that they had already agreed to, President Nixon cranked up the heat on the bombing campaign.

Operation Linebacker II

In response to a directive by the President of the United States, the Joint Chiefs of Staff issued the following order to the commanders in the field:

Figure 1-7.

The A-7 Corsair had an advanced computer bombing system

> "You are directed to commence at approximately 1200Z, 18 December 1972, a three-day maximum effort, repeat maximum effort, of B-52/TACAIR strikes in the Hanoi/Haiphong areas against targets contained in the authorized target list."

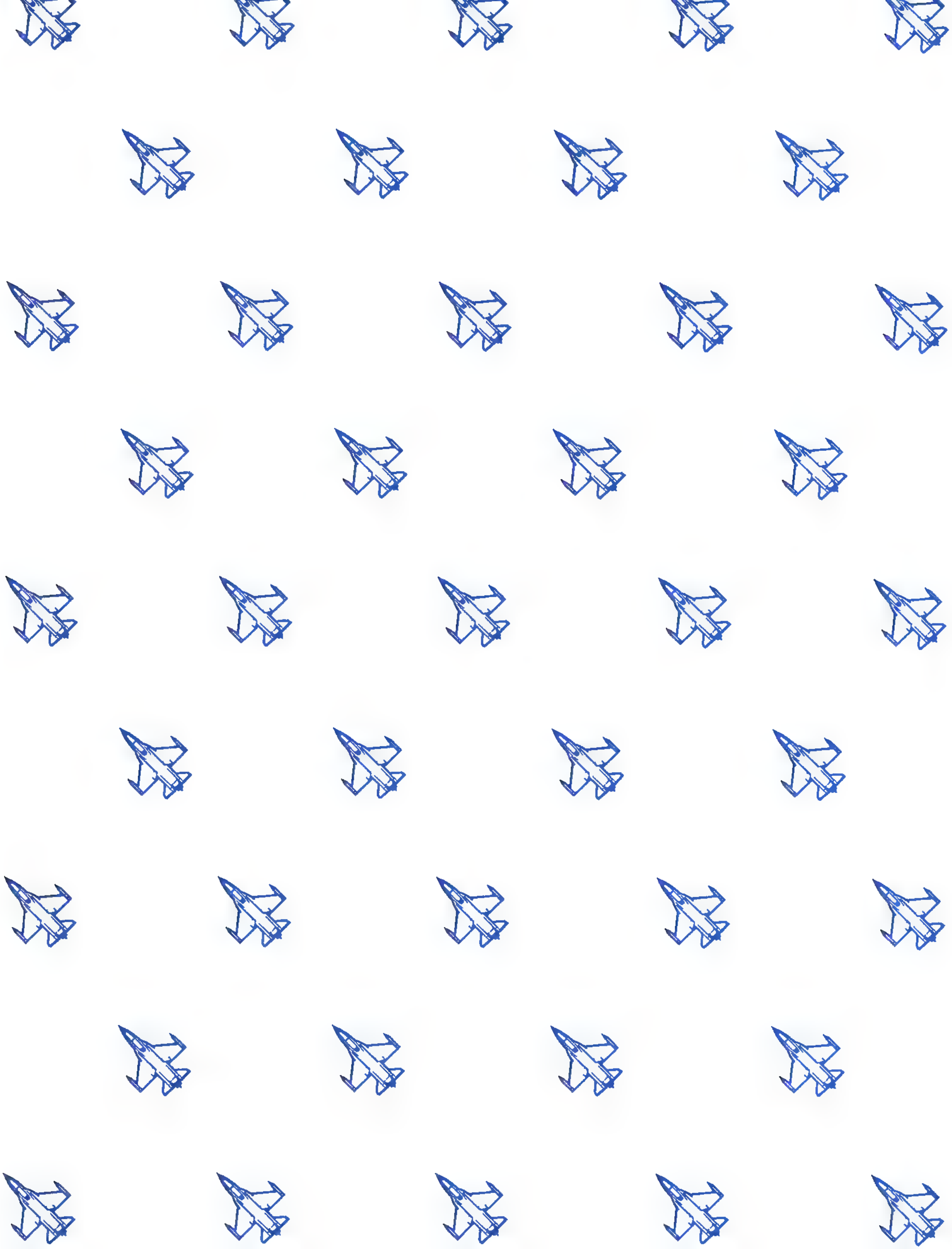
(TACAIR in this message meant tactical aircraft such as fighters.)

The gloves were finally off in the skies over North Vietnam. For the next 11 days, from 18 December through 29 December, the North Vietnamese came face to face with a brutal reality–they were at war with a superpower. Linebacker II was an intense strategic bombing campaign against a wide array of military targets in the Hanoi and Haiphong area. With a loss rate of about two percent overall, the United States dismantled North Vietnamese hydroelectric power stations, railroads, storage areas, and air defense systems with an intensity not seen since the air war over Korea. The targets were still limited, and there were definite restrictions on some targets (notably the North Vietnamese dike system). Even though the targets were more limited than those in Korea, air power had the desired military and political effect on the enemy. The North Vietnamese agreed to peace and the U.S. withdrew from Vietnam.

Lessons from the Korean and Vietnam Wars

Vietnam left a permanent scar on the psyche of American leadership both inside and outside the military. The limits of air power were clearly highlighted in both the Korean and Vietnam Wars. Some limits were not actual technical limitations but rather self-imposed political constraints. In Korea, air power had a much freer reign and was very effective at helping to end the war. Accuracy was still a major limitation of the aircraft of the time but the big bombers were given the freedom to attack strategic targets, which more than made up for this limitation. In Vietnam, the accuracy problems persisted in the beginning of the war and air power was further impeded by the limited target selection imposed on air commanders.

In the last years of the war, the Vietnam experience also provided valuable insight into the strengths and limitations of modern air combat. With the introduction of precision-guided munitions, computed weapons delivery methods, and an intense strategic bombing campaign, the successful Linebacker operations clearly pointed the way for effective tactical air employment in limited wars. The U.S. armed forces took the lessons of Vietnam to heart as it built its force structure and trained for the next war.



CHAPTER

2

THE PROPHECY OF AIR POWER FULFILLED

"Contrary to the skeptics air power proved decisive. High-tech weapons and precision bombing have changed the face of warfare."

–Mortimer Zuckerman
Editor-in-Chief
U.S. News and World Report

Giulio Douhet predicted that air power would become the primary method of waging war on the battlefields of the future. With the fall of South Vietnam to the Communists in 1975, it seemed clear to some that Douhet had been a false prophet. A third-world nation had stood up to a superpower and emerged victorious. The air power of the United States appeared impotent against a determined enemy. The fact that the limited effectiveness of air power was primarily the result of political factors was not recognized in a reform-minded government.

Some commentators of the post-Vietnam period believed that the high-tech weaponry of the United States had failed, and argued that the use of these weapons (which included sophisticated combat aircraft) should be de-emphasized in the force structure of the future. Without careful analysis this simplistic theory appeared to be correct, despite the fact that a move to lower technology weapons refuted over 2,000 years of military history. The consensus outside of the military establishment was that U.S. forces had reached a point of diminishing returns in the application of technology on the battlefield.

Political Views on the Use of Force

The Vietnam experience shaped the views of a generation of political and military leaders of the United States. Two opposing political groups were divided in their interpretation of the lessons of the Vietnam War: the 1976 White House Administration and the 1980 White House Administration represented, respectively, the opposing views.

The Administration that entered the White House in 1976 represented the group on the left, which concluded from Vietnam that a high-tech military force may not be an appropriate tool of national policy. They also believed that the U.S. military had failed in Vietnam because of the inadequacy of military force in general against a well-trained and highly motivated fighting force abroad, and, more specifically, the failure of high-tech weapons against a determined guerrilla army.

Armed with this philosophy, the government lowered defense budgets over the next four years. This is not to say that all defense development ceased during these years or that lowered defense spending precipitated bouts of Soviet aggression in Afghanistan. In fact, some notable programs such as the development of Stealth technology were started by the Defense Advanced Research Projects Agency (DARPA) in the late 1970s.

U.S. Air Power Prepares for the Next War

Not all of the problems encountered by air power in the Vietnam War were caused by the politicians in Washington. While the nation was coming to grips with the failings of the political leadership during the war, as well as the obvious possibility that the United States may have had no reason to be engaging in a war so far away with little more than vague "geopolitical" interests at state, the military was aggressively stepping up to solve the military problems encountered in the conflict. In the aftermath of the Vietnam War, the U.S. Air Force realized that they had some serious self-induced shortcomings.

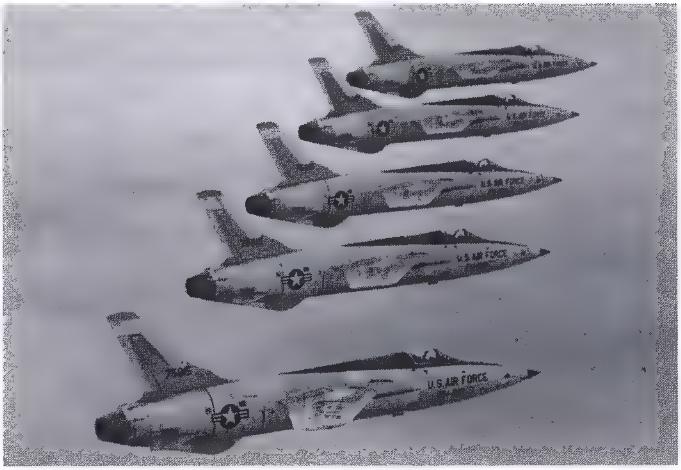
One big problem encountered by the Air Force during Vietnam was the inadequacy of the combat aircraft in the Air Force inventory. In the 1950s the Air Force built fighters to support the doctrine of nuclear deterrence. This doctrine had permeated every arm of the Air Force to include the tactical fighter forces. Fighters during the 1950s and 1960s were built as tactical nuclear bombers or interceptors and were not built to fight a conventional war.

The F-105, shown in Figure 2-1, possessed the classic design attributes that reflected Air Force thinking in the 1950s. This aircraft was designed to carry an internal nuclear bomb load and fly at supersonic speed at low altitude. Maneuverability was sacrificed for size, speed, and stability. The F-105 was later adapted for conventional bombing and the

The F-105D weighed 27500lbs empty and 52546 with a full load. It carried a crew of one.

Figure 2-1.

The F-105 reflected Air Force thinking in the 1950s



internal bomb load was replaced by a fuel tank. Still the aircraft was not well-suited to fill the role as the primary Air Force fighter-bomber in the early years of the Vietnam War.

The other fighter design philosophy of the 1950s was reflected in the F-106, pictured in Figure 2-2. The F-105 represented the nuclear fighter-bomber arm of tactical aviation while the F-106 was an interceptor. It could not carry bombs and was optimized for non-maneuvering air combat at high altitudes against Soviet bomber formations.

Even though the Korean War stood as a model for limited conflicts in the Cold War period, the Air Force was still caught completely flat-footed as the Vietnam War unfolded. At the start of the war the Air Force was stuck with a fighter force built for a nuclear war. Luckily, the U.S. Navy had a maneuverable aircraft available--the F-4 Phantom. The F-4 Phantom, shown in Figure 2-3, soon replaced the F-105 as the backbone

Two McDonnell F-4 Phantom IIs destroyed two MiG-17s over Vietnam in 1965 in what was the first USAF victory of the Vietnam war.

Figure 2-2.

The F-106 represented the interceptor arm of tactical aviation

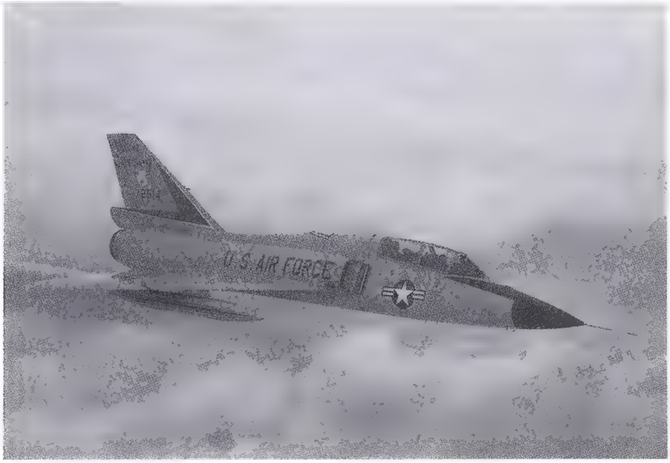


Figure 2-3.

The F-4 Phantom became the workhorse and backbone of tactical fighter aviation in the Vietnam War

of U.S. Air Force tactical fighter aviation in the war (even though it was built by the Navy for fleet air defense).

The F-4 was not a great bomber nor a great air-to-air aircraft but it proved to be a flexible fighter that could accomplish both these missions. The Phantom had the best thrust-to-weight ratio of any fighter in the war and it also possessed the most advanced radar and air-to-air missiles. While the Phantom performed well in the war, it was obvious that the Air Force had gone down the wrong fighter design path in the 1950s. As the war continued through the 1960s the Air Force moved to correct this mistake.

The Development of New Combat Aircraft

The two primary aircraft built in the 1970s to replace the F-4 Phantom were the F-15 Eagle and the F-16 Fighting Falcon. These aircraft, shown in Figures 2-4 and 2-5, have their own

Figure 2-4.

The F-15 Eagle

Figure 2-5.

The F-16 Falcon

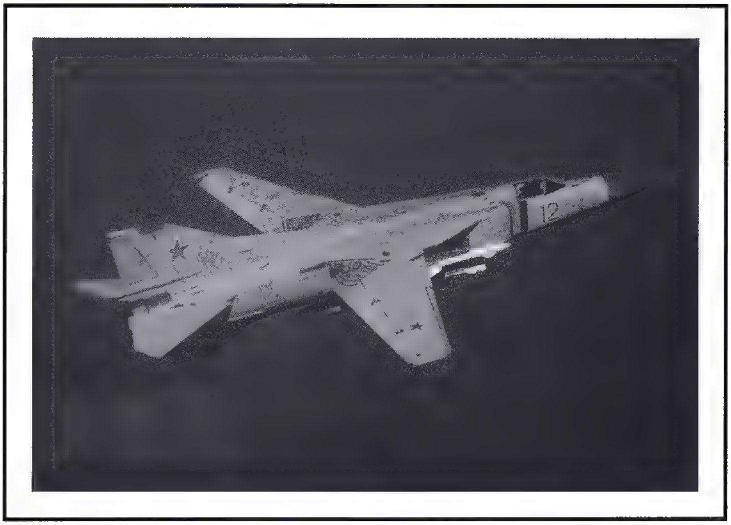
unique development story but both aircraft had a very similar design goal—maneuverability. Together these jets represented the new direction in Air Force fighter design philosophy that replaced nuclear bombing and high-altitude interception with flexibility and maneuverability as the key attributes of conventional fighter combat.

The Falcon Is Born

The conversion of U.S. Air Force fighter squadrons from the F-4 to the F-16 highlighted a dramatic new direction born out of the Vietnam experience. The F-16 development program came about primarily through the fortuitous combination of several forces. The first of course was the shortcomings of the mainstay F-4 Phantom. The other factor that spurred the development of the new generation of fighters was the development of a new generation of Soviet fighters.

Figure 2-6.

The MiG-23 Flogger



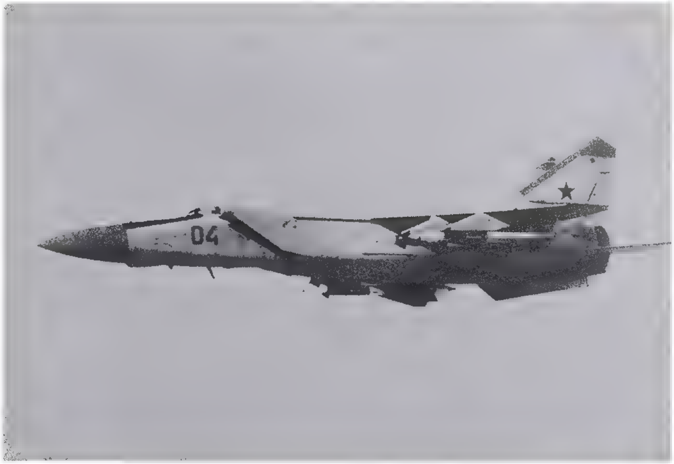


Figure 2-7.

The MiG-25 Foxbat

In July of 1967 at the Domodedovo airfield near Moscow, several new Soviet fighters were displayed for the first time to the Western press. The aircraft that had the most dramatic impact and caused the greatest concern were the MiG-23 Flogger, shown in Figure 2-6, and the MiG-25 Foxbat, shown in Figure 2-7. The MiG-23 had variable sweep wings and a sleek aerodynamic design. It was the predecessor to the formidable MiG-21 Fishbed that the North Vietnamese used so effectively against the F-4.

The F-4 had a range and armament advantage over the Fishbed but the F-4's new air-to-air missiles had not obviated the need for maneuverability. In this area the MiG-21 had a clear advantage. Now the Soviets were introducing a new prototype aircraft with improved range and armament that included air-to-air missiles of the same type carried by the F-4.

The Soviets began their involvement in Afghanistan on 24 December 1979 with an airlift of 5,000 soldiers into Kabul. MiG-21s and MiG-23s provided armed escort for the transport aircraft that carried the troops.

In addition to these improvements, the MiG-23 was even faster than the MiG-21.

The appearance of the MiG-25 at Domodedovo did for U.S. fighter development what the appearance of Sputnik did for the U.S. space program. The Foxbat was a large twin engine fighter with unprecedented performance. In addition, it was equipped with a new high-powered radar and long-range air-to-air missiles. The West had no fighter aircraft that could fly as fast or as high as the Foxbat. The introduction of this jet by the Soviets sent tremors through the American fighter community.

Almost a decade after the Foxbat was first displayed to the West a Russian pilot defected with a Foxbat and landed in Japan. Careful analysis of the aircraft by the U.S. intelligence community proved many of our initial fears to be unfounded. It did not have the ability to fly at high speeds at medium or low altitudes as we had first postulated and it was not a very maneuverable jet. The conclusion of the Foxbat analysis, however, was that it was a remarkable fighter in the very high-altitude, high-speed regimes where it was designed to operate.

The MiG-25 Foxbat was able to travel at Mach 3.

In the 1960s the U. S. Air Force had begun to investigate design options for a true air superiority fighter in the mold of the P-51 Mustang and F-86 Sabre. The project was designated Fighter Experimental or FX and moved at a snail's pace until the Soviets unveiled their new fighters at Domodedovo. The Foxbat was especially troublesome because its estimated altitude and speed performance made it invulnerable to the mainstay American fighter, the F-4 Phantom. The FX project was injected with new energy after the Foxbat was unveiled, and parameters for the new fighter were developed to make the FX superior to the Foxbat.

The Lightweight Fighter

During the early stages of the FX project in the mid 1960s a concept emerged called the Advanced Day Fighter (ADF). This concept called for a smaller aircraft that could out-perform the MiG-21, yet be cheaper and simpler than the FX. The appearance of the Foxbat put the ADF concept on hold and the new FX (now called the F-15) went forward as the highest priority Air Force fighter project. As the F-15 project got under way the Air Force realized that its high cost and complexity would limit the number of F-15s that could be manufactured. The cost for the F-15 and the new Navy fighter, the F-14, was five times higher than the previous generation of fighters; 2 million for the F-4 versus 10 million for either the F-14 or F-15.

A new concept of competitive prototyping was introduced by Deputy Secretary of Defense David A. Packard to reverse the trend of large, high-cost fighters. The ADF, now called the Lightweight Fighter (LWF) project, came to the forefront as a candidate for this new approach to aircraft development. This procurement strategy called for creating multiple fighter aircraft designs that together would meet broad objectives rather than having one expensive fighter designed to meet exact specifications.

The General Dynamics YF-16 prototype was on its maiden flight when it went up against Northrop's YF-17 on 2 February 1974. It was flown at the speed of Mach 2 that day for the first time.

The cost of the F-15 had soared in response to the need for a long-range air-to-air radar and high-Mach capability to fight the Foxbat. The LWF would be free of meeting specific military operational needs and would be allowed to pursue advanced technology options in fighter design. The different fighter designs would then be flown in competition with each other to determine which one, if any, should be bought. Northrop and General Dynamics won the initial contracts to build prototypes and the YF-17 and YF-16 were developed. The "Y" in the prefix of the designation was used instead of the classic "X" to denote that the aircraft was not purely an experimental design but used a combination of new and off-the-shelf technology.

Both teams produced unique designs to accomplish the same fundamental goal of producing a small, maneuverable fighter aircraft. The General Dynamics YF-16, shown in Figure 2-8, had a single engine, complete fly-by-wire flight controls, a side stick controller, and a 30 degree reclined seat. In addition, it was the first fighter to feature "relaxed static stability," which, in effect, allows the horizontal tail to produce an

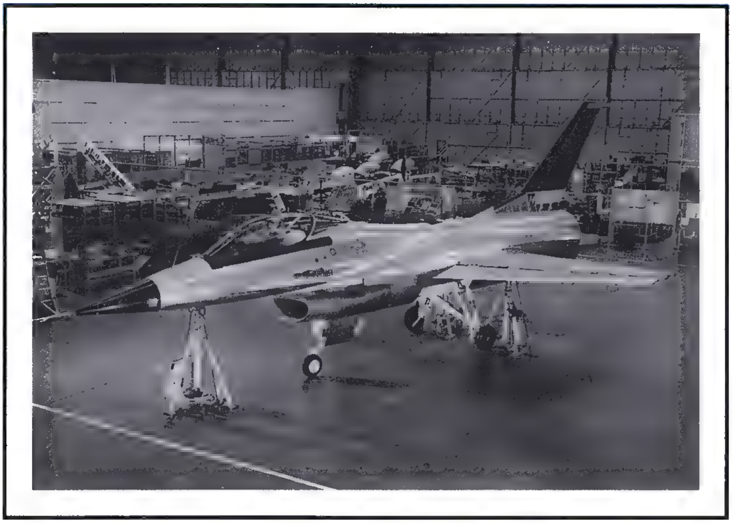


Figure 2-8.

The General Dynamics YF-16 Prototype

upward lift vector to aid in turning the aircraft. A conventional aircraft such as the F-15 and the YF-17 possesses static stability that by necessity requires the tail to produce a down lift vector, which hinders turning ability. The YF-17 was a twin engine aircraft with partial fly-by-wire flight controls, a conventional center control stick, and distinctive twin vertical tails.

The differences in the two aircraft were primarily of form rather than function. Both aircraft were highly maneuverable and had similar range and payload capabilities. The two were rated similarly in most objective measures of performance with the edge going to the General Dynamics YF-16 in cost, range, acceleration, and turning ability near the supersonic speed range. During flight testing of the prototypes the Air Force announced that the winning aircraft would go into full-scale production to become the low-end fighter in the new high/low air combat concept.

The High/Low Mix

The high/low mix concept was developed by the Air Force in response to the growing trend to produce large, complicated, and costly fighters such as the F-15 that could only be built in small numbers. The high/low mix was a brave attempt by the Air Force to stand up and face the reality of air combat. This reality, known intuitively by fighter pilots, is that at a given ratio, numbers count more than aircraft capability. That is, you can beat superior odds with superior aircraft and training only to a certain point. After that point, even the fastest, most maneuverable jets will be overpowered by a large number of enemy fighters. The trend toward a small number of very capable aircraft might be yet another concept that would not survive the test of combat.

The post-Vietnam leadership in the Air Force wisely weighed the effects of numbers and aircraft capabilities and concluded that the F-16 was affordable enough to provide the numbers to make the high/low mix strategy work. The F-16 was a very capable fighter but did not possess a long-range radar and was not equipped with a radar-guided air-to-air missile. The F-15/F-16 mix would allow sufficient numbers and complementary capabilities. Both aircraft were maneuverable with the edge going to the F-16 and both aircraft had good weapon systems with the F-15 having the advantage.

A final word about the high/low mix philosophy and the F-16. This concept has proved successful, but in a way that is quite different from what was originally envisioned. Over the last decade, the F-16 has evolved from a pure low-cost, lightweight fighter to a multi-purpose aircraft in the same vein as the F-4. This evolution was brought about by two major factors. The first is the aircraft's great flexibility to adapt to a wide range of fighter missions. The second is the relative low cost of the F-16, which allows it to be bought in sufficient numbers to have an impact. The high/low mix strategy now involves having a small number of expensive aircraft for specialized missions–such as the F-15E for all-weather day/night attack–and a large number of less expensive multi-mission F-16s. The Air Force solved the aircraft problems that surfaced in the Vietnam War primarily by developing the highly reliable and lethal F-16 and F-15 fighters.

Training

Another shortcoming of the Vietnam-era Air Force was fighter pilot training. After the Korean War, air-to-air missile technology emerged in the form of the Aim-9 Sidewinder and the Aim-7 Sparrow missiles. With the introduction of air-to-air missiles it became clear to some non-fighter pilot "experts" that air-to-air combat would be dominated by non-maneuvering missile engagements. Training for maneuvering air combat engagements has always been dangerous, so conventional wisdom during the Vietnam War concluded that practicing maneuvering air combat was not worth the risk in the air-to-air missile era. Of course just the opposite proved to be true.

The introduction of complex weapons required increased realistic training on the part of fighter pilots. Unfortunately this fact was not discovered until after the Vietnam War and a generation of fighter pilots went to war with very poor air-to-air combat skills.

Red Flag

After the war, Air Force analysis of the air-to-air combat engagements showed how poorly most pilots performed in engagements with North Vietnamese MiG aircraft. The overall kill ratio dropped to two MiGs killed for every one U.S. fighter lost to air combat, from ten MiGs to every one U.S. fighter during the Korean War. In order to address this problem the Air Force introduced the Red Flag exercise at Nellis Air Force Base in Nevada. These exercises created the most realistic combat environments short of an actual war.

In addition to Red Flag and similar exercises, the Air Force followed the Navy's lead and started to fly Dissimilar Air Combat Tactics (DACT) sorties. These missions were air-to-air sorties against different kinds of aircraft. Unbelievably, pilots sent to Vietnam did not receive this type of training, which in part explained their poor performance against the North Vietnamese MiGs. Red Flag-type exercises along with

DACT sorties reshaped a new generation of fighter pilots and turned the F-15/F-16 Air Force into a formidable fighting force.

Desert Storm

In August of 1990 Iraq invaded Kuwait. In two days Kuwait was swallowed whole and the world watched as the Iraqi Army massed along the Saudi border. Saddam Hussein, a former United States crony, had thumbed his nose at world opinion. His invasion of Kuwait was based upon two fundamental assumptions. The first assumption was that the U.S. did not have the stomach for a land war on foreign soil. The second was if the U.S. did become involved in a conflict in the Middle East it would take a bloody and protracted land war to remove a dug-in Iraqi army from Kuwait. This land war could be won by Iraq because Iraq would be willing to take the most losses in a protracted war of attrition.

These assumptions were not as farfetched as they now seem through the clear vision of hindsight. The last time the United States had entered a ground conflict on foreign soil the country had suffered a political defeat and been forced to withdraw without achieving victory; moreover, conditions in Vietnam clearly favored guerilla tactics, as opposed to the open desert terrain in Kuwait and Iraq. Secondly, the high-tech weapons that made up the U.S. military machine had yet to be proven in combat. In fact, in the ten-year Iran-Iraq War, high-tech weapons played only a minor part and the air forces of both sides proved markedly ineffective.

Even in the United States, a number of respected analysts outside the military blasted high-tech weapons. They wrote eloquently and convincingly that air power had never been decisive in war. They argued that the infantryman was the only decisive force on the battlefield and that air forces had become too high tech and too far removed from the realities of ground combat.

It is not hard to see why Saddam Hussein believed that he could take and hold Kuwait. He had a million-soldier army that was well-armed and battle-hardened from ten years of war with Iran. His equipment was the best that money could buy and supplied by the East and the West. His army could withstand heavy losses and his people great suffering without significant internal political turmoil. Further, he had erected a formidable air defense system that had beaten back the Iranian Air Force and had since been expanded through an extensive modernization program. Saddam Hussein and his henchmen stood ready to make their mark on Arab history by standing up to a United States military far from home.

The Speed Bump Division

Unfortunately for Saddam it was not the Vietnam era U.S. military that showed up for this war. It was instead the modern U.S. armed forces bristling with the latest military equipment and manned with highly trained military personnel. The people that made up the U.S. armed forces were completely confident in their cause (due in part to the intellectually dishonest propaganda that we were fighting for Kuwait's freedom, though Kuwait is far from an equalitarian, democratic society) and the power of their arms. In the hours that followed the invasion of Kuwait, the U.S. sent forces to block the advance of the Iraqi Army into Saudi Arabia. This force consisted primarily of combat aircraft and lightly armed infantry but the deployment was made quickly and without hesitation.

One of the ground units that were the first to arrive was the 82nd Airborne Division. This force was lightly armed and had very few heavy weapons so it was called the Speed Bump Division. This division and others like it that arrived in the first few days of the conflict had the benefit of massive air power support. The U.S. Air Force deployed hundreds of fighters to the area within a few days of the invasion of Kuwait and these aircraft soon were flying hundreds of sorties to deter Iraqi attack. The Iraqi advance stopped at the Saudi border because the United States had quickly placed ground troops in the path of a massive invasion force and backed them up with air power (the first air-to-ground capable fighter units to arrive in the theater were F-16s from the 388th Tactical Fighter Wing from Hill AFB, Utah).

Over the coming weeks (which soon turned into months) the deployment of multi-national military forces to Saudi Arabia continued unabated. One month after the invasion began the Iraqis had lost the initiative and were forced into a defensive strategy to hold Kuwait. Despite the rapid deployment of U.S. forces to the region the Iraqis remained confident in the strength of their position. Deploying forces to Saudi was one thing but fighting was still another. The battle-hardened Iraqis dug in and waited to fight a ground war of attrition with the coalition forces.

Fixed Fortifications

General Patton once said, "fixed fortifications are a monument to the stupidity of man." Given that this statement is true, the Iraqis had elevated military stupidity to an art form. In their ten-year war with Iran they had perfected a defensive in-depth strategy that featured a series of well-fortified obstacles consisting of trenches, minefields, and dug-in armor.

Backing up these fixed defenses were armored troops in the form of the "elite" Republican Guard. The objective of these troops was to respond to a breach in the forward line by executing a violent counterattack. Using this strategy the Iraqis had caused massive casualties against the human wave attacks of the Iranians and stalemated the Iranian advance. Of course there was one important combat element that was missing from their war with Iran—air power.

During this war the aircraft of both sides were used in limited hit-and-run operations rather than a sustained air campaign. In addition, the two armies that had squared off in the war were both woefully incompetent by modern standards. While Iraq and Iran possessed modern equipment, their armed forces were poorly trained and lacked skilled leadership. The corresponding tactical perspective gained by the leadership of both sides during this conflict really had no merit outside the confines of the Iran-Iraq War. As the Desert Shield deployment continued, the Iraqis confidently waited behind their fixed ground and air defenses (the same way the French had huddled behind the Maginot Line on the eve of the German invasion). Patton would again be proven correct.

Iraq Routed

The Iraqis grossly overrated their fighting abilities by judging the performance of their armed forces based on a conflict with an equally incompetent force. This, coupled with their false impressions about the military strength and political resolve of the coalition forces, led them to disaster. The U.S. Air Force had the expertise to roll back the Soviet Integrated Air Defense System in Eastern Europe, which was far more sophisticated than the Iraqi Air Defense System. In fact, on the eve of Desert Storm the Air Force had deployed a mere one sixth of their fighter forces to the region to pummel Iraq's huge army.

On the night the war started, the Air Force along with Allied air forces and Navy aircraft hit targets in Iraq and Kuwait in a massive air attack. The plan was a very straightforward Offensive Counter Air (OCA) campaign that was designed to gain air superiority over the battlefield. The first targets struck were Iraqi airfields and air defense nodes. Next came the power stations. The U.S. military had pledged that in the next war they would place the enemy in the dark at the start of the war and keep them in the dark. The Air Force and Navy had not been allowed to do this to the North Vietnamese during the Vietnam War and the capital of Hanoi remained relatively peaceful throughout the war with business continuing as usual.

This time the U.S. Air Force and Navy attacked the power stations in the first few hours of the war, knocking out power to virtually all Iraqi cities. After a week of bombing the OCA campaign achieved the objective of destroying the Iraqi Air Defense System and Allied air power then switched to an Interdiction campaign against dug-in troops and enemy supply lines. The air war lasted a mere 39 days and the Allies' loss rate was less than half of one percent–a staggering number considering the loss rate in the air war in Vietnam was around two percent. If the U.S. had sustained a loss rate of two percent during the Gulf War, 2,200 aircraft would have been lost. In the war with Iraq over 110,000 sorties were flown with only 43 aircraft shot down.

What is even more impressive than the low loss rate was the effect of the 39-day air war on the enemy. This was the first war that was won almost entirely with air power. The fact that the Iraqis did not surrender before the start of the ground war is irrelevant. The Allies could have kept pounding the Iraqis for months if necessary; however, it became increasingly clear toward the end of the air campaign that the Iraqis were beaten. All that was needed to end the war was a mop-up operation by the ground forces. The ground offensive against a beaten and disorganized Iraqi Army lasted only 100 hours and was assisted by massive air support. As the Allied army advanced, the Iraqis were flushed from their positions and surrendered, fled, or were destroyed by air power. The few Iraqi units that stood their ground and fought were cut to pieces by well-trained U.S. Army and Marine ground forces. The war was over with only minimal Allied casualties. Of course, hundreds of thousands of Iraqis were killed or injured as a result of this war, and the United States military minimized and controlled press coverage of "collateral damage"—a sanitized term for the taking of civilian lives.

The Supremacy of Air Power

Air power had proved decisive. Giulio Douhet had been right. An air armada had engaged and destroyed the enemy before ground armies could engage in combat. Unlike the successful B-29 nuclear strikes on Japan, this was a sustained conventional bombing campaign. Never before had air power been so overwhelming. What had changed over the last two decades since the Vietnam War? The first major change was the lethality of the aircraft themselves. The fighter-bombers of the Vietnam War were only marginally better than the bombers of World War II. The fighter-bombers used in Desert Storm had sophisticated computed bombing systems such as the armament delivery systems of the F-16. Other aircraft used laser-guided bombs (LGBs) and highly accurate Maverick missiles.

Another aircraft-related change was the low maintenance hours required to fly modern fighters. This allowed relatively few fighters to fly a large number of sorties and deliver highly accurate payloads despite hostile desert conditions.

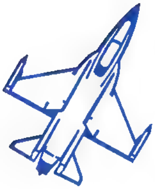
Still another improvement over the Vietnam era application of air power was the survivability of modern fighters. Using reduced observable technology, active and passive countermeasures, and highly maneuverable aircraft, air power dominated the battlefield and suffered very few losses.

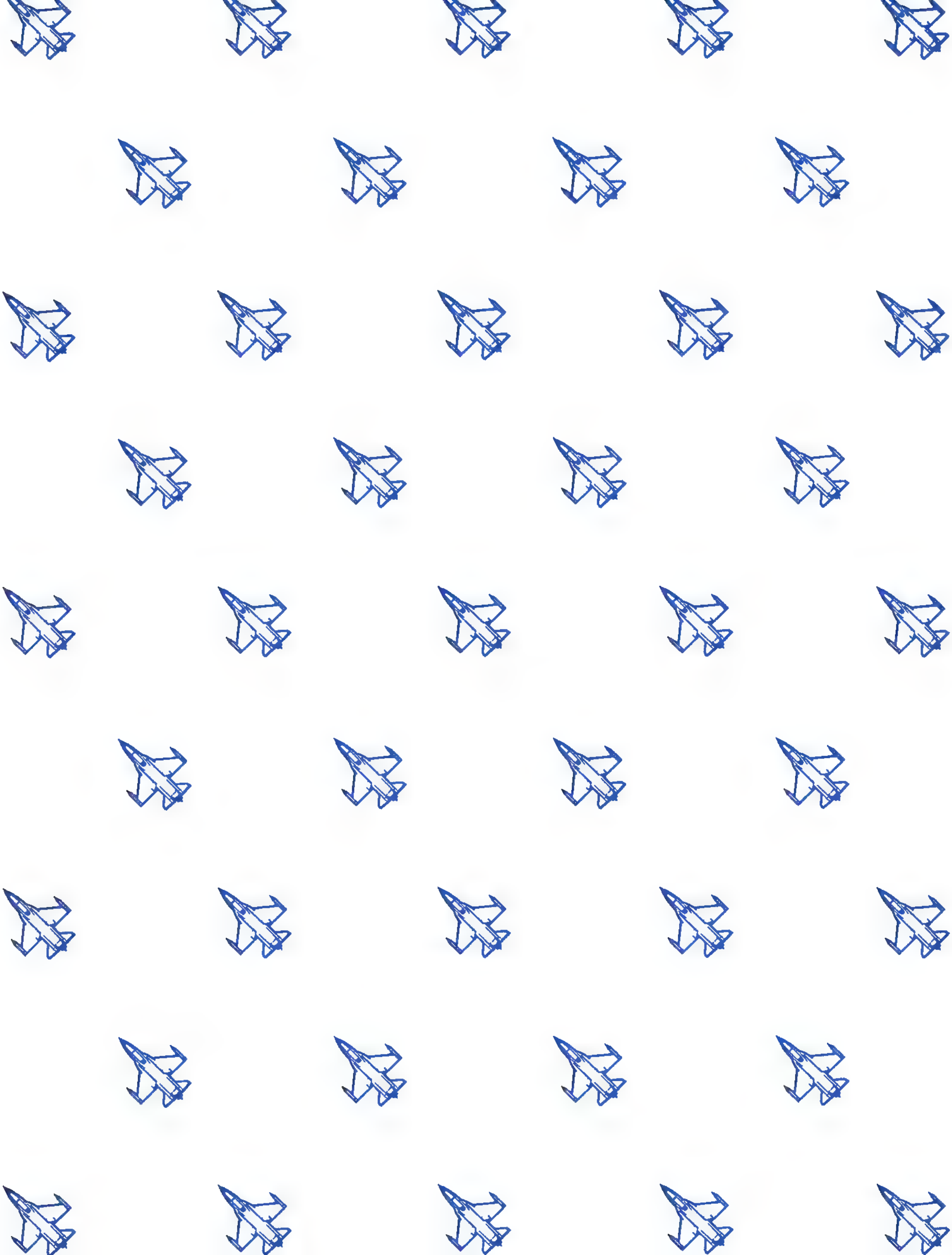
The biggest change over the last major war waged by the U.S., however, was in the political will to use the necessary force to do the job. In Desert Storm the Allied air forces were given freedom to attack the targets of their choice with the number of aircraft and weapons required to complete their mission.

The F-16 Fighting Falcon

The future of air power is bright. With the conclusion of Desert Storm we have finally arrived at an era in armed conflict predicted by the early aviation advocates—the dominance of air power on the battlefield. Aircraft such as the F-16, shown back in Figure 2-5, are a large reason for the success of air power.

In Desert Storm, the F-16 Fighting Falcon flew more sorties than any other aircraft in the war. The F-16 embodies two of the primary characteristics of successful modern combat aircraft: outstanding thrust-to-weight ratio and state of the art avionics. Falcon 3.0 will let you experience the thrill of flying the F-16 but just as important it will allow you to command a squadron in a modern air campaign. These first two chapters have given a historical perspective of the evolution of air power; the rest of this book will give you the specific tactical knowledge to win in Falcon 3.0.





CHAPTER

3

FALCON FUNDAMENTALS

"The air battle is not necessarily won at the time of the battle."

—Pappy Boyington\WWII American Ace

The primary mission of the fighter pilot is deceptively simple: to return home at the end of a hard day's work. Being able to do this entails a lot of training. Fighter pilots must first learn to master flight; only then can they take on the many tasks involved with flying *and* fighting.

Fighter pilots training to fly the F-16 spend one year flying the T-37 and T-38 jet trainers, three months in Fighter Lead-In Training (again flying the T-38), and five months in F-16 Training. They spend the next two to three months with their squadrons training for Mission Qualification. After two years of training, students are called combat-ready but real combat had better be another one to two years away; at this point the "clue bag" of the new fighter pilot is still woefully empty. These new fighter pilots will need at least a year to get a grip on the fighter business, and acquire all of the skills needed to be effective in aerial combat.

Your training as a Falcon 3.0 pilot started with a historical perspective. The next few chapters will expand your knowledge by providing you with hands-on training and air combat techniques. This training will make you a combat-ready fighter pilot in record time. This is possible, of course, because in the Falcon 3.0 simulation you have only your pride to lose if you make a mistake.

Aerodynamics

Training starts with a very brief discussion of aerodynamics. *Aerodynamics* (or aero as pilots refer to it) is the engineering science that explains why aircraft fly. You do not need an in-depth understanding of aero to fly Falcon 3.0, but you should know the forces that act on an aircraft in flight, and how they apply to F-16 performance.

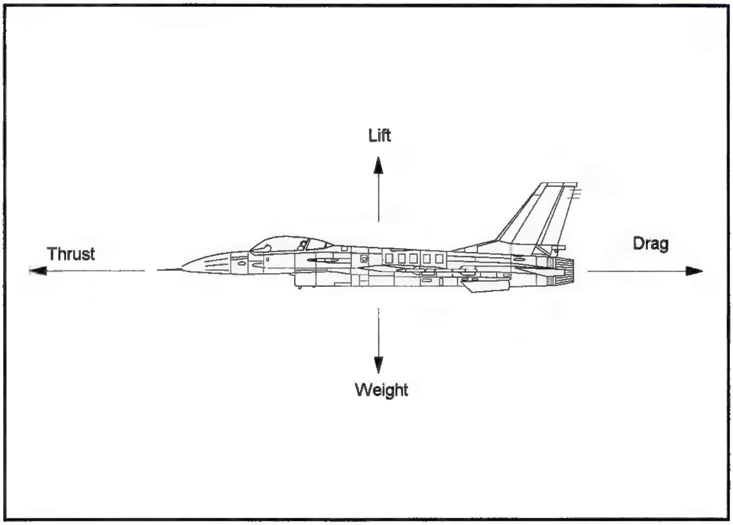
The Forces Acting on the Jet

Thrust is the force that is directed out of the nose of the aircraft. This force, shown in Figure 3-1, is created when the engine pushes air out of the back of the jet.

The jet engine sucks air into the intake, squeezes it in the compressor, mixes it with fuel, and ignites it in the combustion section. This air rapidly expands at ignition, and, when directed out of the back end of the jet, the pressure of air expansion propels the jet forward. You control this action with the *throttle*. The higher you push the throttle, the more

Figure 3-1.

The forces on a jet—thrust, lift, weight, and drag



thrust you get until you are at full Military power (MIL). *Military power* refers to normal, non-afterburning throttle settings. The *afterburner* (AB) is a section of the engine that can be selected by the pilot with the throttle. When selected, it dumps fuel into the aft end of the engine and ignites it, producing up to 40 percent more thrust (25000lbs in AB versus 15000lbs in MIL). The AB gives you a large increase in thrust but it also burns up a lot of fuel (up to four times more than Military power).

Drag is the force acting opposite thrust. Figure 3-1 shows drag acting from the tail of the aircraft. Drag is produced anytime you push something (such as an airplane) through the air, causing friction between the air and the aircraft body. The smaller the frontal area of your aircraft, the lower the drag, and the less thrust needed. Drag is also a function of design. A Corvette, for example, has a very *clean* aerodynamic design and low drag compared to a Jeep, which has a relatively *dirty*, high-drag design. Aircraft are the same as cars in this respect. An F-16 has less drag due to air friction than an F-4 because of the F-16's smaller front and cleaner design. If you hang bombs on the F-16, however, you increase the frontal area and dirty up the aircraft, thereby increasing drag.

The battle of Verdun, which began on 21 February 1916, was the first major battle in which large formations of fighter planes were used.

Lift is the force that counters the weight of the aircraft and enables it to fly. Lift is produced by the wings (and the fuselage in the F-16) and is directed toward the top of the jet, perpendicular to your flight path. Figure 3-1 shows the position of the lift vector (a vector is force acting in a certain direction).

Weight is also shown in Figure 3-1. *Weight* is the force on the aircraft that pulls it toward the earth. It is different from the other forces discussed because nothing you do with your aircraft affects weight. If you dive straight down in your Falcon, weight will act in the same direction as thrust–straight down. Conversely, if you climb straight up, weight still pulls straight down towards the earth, opposing thrust.

Now that you know why the pointy end of the jet goes through the sky first, it's time to discuss maneuvering.

The Mechanics of Flight

As you sit in the "cockpit" of the Falcon, picture a line that runs from the nose of the airplane, through the cockpit, and out the tail of the jet. This line is called the *roll axis*; *roll* is movement of the aircraft wings around this line.

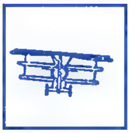
Turn is movement of the nose that occurs as a result of rolling the aircraft. When you roll the wings of the aircraft and then stop the roll, you establish a *bank angle*. This angle is measured between the wings of your aircraft and the horizon. When you establish a bank with the wings, the aircraft turns in the direction of the low wing.

The rate at which the aircraft turns is determined in part by the *Gs* that the pilot pulls. (*Gs* are measured in Earth gravity; 3 *Gs* equals 3 times Earth's gravity.) The higher the *Gs* commanded by the pilot, the faster the aircraft turns (assuming a constant airspeed). The specifics of pulling *Gs* in Falcon will be covered later in this chapter.

For now, you need to understand that during a level turn (assuming a constant altitude), there is a relationship between bank angle and *Gs*. A pilot who wants to execute a 2*G* level turn, for example, must use 60 degrees of aircraft bank. A 6*G* turn requires 80 degrees of bank. Figure 3-2 shows aircraft *Gs* and the corresponding proper bank angle for a level turn. If you do not bank the aircraft at the proper bank angle for a particular *G* load, you will climb or descend. If you were at 60 degrees of bank and pulled 3*Gs*, the jet would climb. If you only pull 1.5*Gs* at 60 degrees of bank, the aircraft would descend.

Acceleration is simply speeding up or slowing down. This is accomplished in Falcon by increasing or decreasing power. Weight and drag also affect how fast you accelerate or decelerate.

Remember: *Airplanes can do only a few basic things, like roll, turn, accelerate, and decelerate. The Red Baron's Fokker Tri-plane, United's Flight 205 to Chicago, and the Falcon simulation are all limited by these basic maneuvers.*



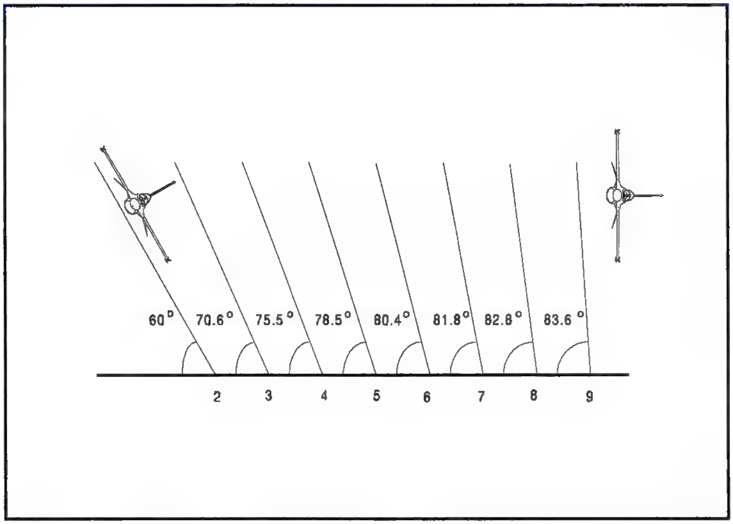
The first aerial bombers were pennon kites, first used in 1326 in Europe.

The Briefing

Now that you have a few flight fundamentals under your belt, it's time to prepare for a training flight in Falcon 3.0. The rest of this chapter will walk you through a training flight and will

Figure 3-2.

Gs and the corresponding bank angle



cover all the basic skills needed to fly in the Falcon simulation. Falcon 3.0 comes with tutorial missions that provide mission parameters for learning certain flight basics such as takeoff, flight maneuvers, and that all-important landing. While learning how to accomplish these feats, you will become familiar with the cockpit and instruments of the F-16. While you're airborne, for all intents and purposes, these cockpit instruments function as your eyes and ears.

Learning to Fly

Lesson 1

From the War Room, choose a squadron and proceed to Red Flag. Red Flag is an air combat training program located at Nellis AFB near Reno, Nevada. Incoming pilots from different bases come and fly against the resident Aggressor squadrons who have been heavily trained in potential enemies' (that is, until recently, MiG/USSR) combat tactics.

Choose Lesson 1, and proceed to the pilot screen by clicking on the F-16 Pilots bar. Select any pilot–for now, your selections won't have any consequence until you begin actual combat. However, keep in mind that each pilot selection has strengths and weaknesses in areas such as maneuvering, bombing, and air-to-air combat. Successfully completing a Red Flag mission will raise certain relevant statistics in your selected pilot, so you may want to choose a pilot with a weak skill you'd like to work on.

Proceed to the next screen by clicking on the F-16 bar. Don't worry about loading armaments quite yet; there are no hostiles in the air while you are still in flight school. Click on Takeoff and you'll find yourself strapped in the cockpit of a F-16, ready for takeoff.

The Preflight

The *preflight,* as the name implies, consists of checks and procedures that are performed by the pilot prior to takeoff. F-16 pilots start the preflight when they arrive at the jet. The first thing the pilot does is check the aircraft forms. All aircraft have a set of forms that show the jet's flying record. These forms contain information such as how much gas was put in the airplane, what systems are broken or degraded, and who flew the jet on the previous flight.

After reviewing the forms, the pilot performs a walk around inspection. The walk around is an external inspection of the jet made just prior to strapping in. In the Falcon 3.0 simulation, your preflight will consist of choosing a pilot and selecting armament screens. These screens perform various important preflight functions outlined later in the book.

The Cockpit

The first time I (Pete Bonanni) looked inside the cockpit of the F-16, I felt like a hog looking at a wristwatch. After a few flights I became familiar with the cockpit layout and developed habits to effectively use all of the information displayed. The same will hold true for you in Falcon 3.0. Don't be overwhelmed by the volume of data that is presented to you in the cockpit. Now is the time to familiarize yourself with the parts of your cockpit and Heads Up Display (HUD), discussed next, which you will use during takeoff. The cockpit is depicted in Figure 3-3 with the primary gauges and instruments labeled.

Don't be alarmed at the amount of data in front of you—you'll learn to use these instruments gradually, and soon your use of them will be second nature.

The Heads Up Display (HUD)

The most important part of the cockpit is the Heads Up Display—the HUD. The HUD is a sophisticated device you use for everything from weapons delivery to landing the aircraft. In Falcon 3.0 you can display either the F-16A HUD or the F-16C HUD. The figures in this book show the F-16A HUD since you'll probably use it more often. It has vertical displays for airspeed and altitude and a Five-Mile-Range Scale when in A-A missile mode, all of which do not appear in the simpler F-16C HUD. Figure 3-3 shows the F-16A HUD with important displays labeled. The HUD makes your task easier by projecting certain vital information right onto the cockpit window. Next, you'll review the basic displays you'll use to get your Falcon off the tarmac and into the wild blue yonder.

Note: *If the picture on your computer screen does not look like Figure 3-3 after leaving the Armament screen, press the 3 key to get to the center cockpit display. The 4 key gives you the left cockpit view and the 6 key gives you the right cockpit view. The 5 key provides you with that all important six o'clock (your "six") view out of the back of the jet.*

The Airspeed Scale On the left side of your HUD is the Airspeed Scale, which measures speed in tens of nautical miles (knots) per hour.

The Altitude Scale To the right of the Pitch Ladder is the Altitude Scale, which indicates your approximate altitude in thousands of feet. This scale corresponds with the number in the lower-right corner of your HUD, which gives your exact altitude.

The Pitch Ladder The two sets of five horizontal bars across the middle of your HUD are your Pitch Ladder. Note the numbers on either side of the Pitch Ladder—they indicate

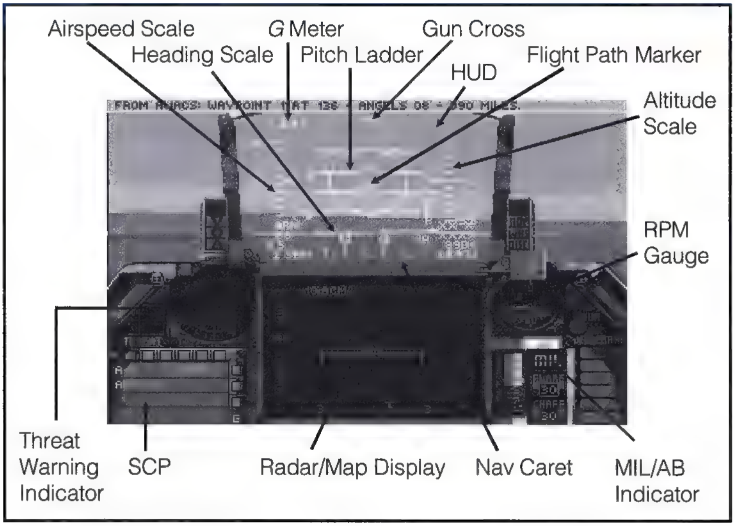


Figure 3-3.

The instruments of the Falcon 3.0 cockpit

the degree of climb or dive. If you are climbing, these bars will be solid and the numbers will be positive. If you are diving, the bars will be dashed and the numbers will be negative.

The Flight Path Marker The Flight Path Marker is a circle with small wings and a small vertical tail that shows the direction your jet is moving through the sky relative to the horizon. The Flight Path Marker, when used in conjunction with the Pitch Ladder, gives you your best cockpit reference for flying the jet. If you want to level off, for example, place the Flight Path Marker on the 10 Pitch Line and the jet will stay level. If you place the Flight Path Marker on the 1 Pitch Line, the jet will climb at a ten-degree angle.

The Heading Scale The Heading Scale is a sliding horizontal scale at the bottom of the HUD that displays the direction of the aircraft over the ground (its heading) in tens of degrees.

A vertical line in the center of the scale marks the heading. If this vertical line were on 09, the aircraft heading would be 090 degrees (north is 0 degrees, east is 90 degrees, and so on). This scale shifts to the top of the HUD in the Air-to-Ground weapons modes to accommodate the HUD Air-to-Ground aiming symbology displayed in the lower portion of the HUD.

The Nav Caret The Nav Caret (Navigational Caret) appears as a ^ on your Heading Scale, and provides a steering cue towards your next waypoint. The Nav Caret and waypoints are covered in more detail in Chapter 6.

Remember: *Nobody with a hundred-pound head wonders whether or not they are in a high-G turn. In the simulation you can't feel the Gs, so you must reference the G Meter in the HUD.*

The G Meter The *G* Meter, located in the top-left corner of the HUD, indicates current aircraft *G*s to the nearest tenth of a *G*. Since the simulation does not give you a "seat of the pants" reference for how hard you are turning, this *G* Meter is important. In a real F-16, when you start a hard turn, there is no doubt in your mind that you are at high *G*. The jet rudely slams you into the seat as the *G*s build, and your head weighs close to a hundred pounds during the turn.

The Gun Cross The Gun Cross is a fixed reference at the top of the HUD that shows the departure line of your 20-mm cannon fire. The bullets fly out of the jet at the Gun Cross. You will learn the significance of the Gun Cross as an aiming reference in the next chapter.

These are the primary HUD displays that will be used for this training flight. Other weapon-specific HUD displays will be addressed in later chapters.

The RPM Indicator

Just below and to the right of the HUD is your RPM Indicator. This gauge indicates your throttle, or how much thrust your engine is producing.

The Center Cockpit Display

The center cockpit, shown in Figure 3-3, has several important displays and gauges that are not located in the HUD.

The Radar/Map Display The Radar/Map Display is also known as the MAP Screen. It shows the Falcon radar or a map of the area with your aircraft position displayed as a flashing square. You can toggle between radar and map by pressing the C key.

The Stores Control Panel (SCP) The Stores Control Panel (SCP) is located to the left of the radar, and it displays the current weapon modes selected.

The Threat Warning Indicator The Threat Warning Indicator is located above the SCP. It displays the presence of MiGs or enemy Surface-to-Air Missiles (SAMs) as squares on the screen. This gives you the relative azimuth (location relative to your jet) of the threat. The Threat Warning Indicator is covered in more detail in Chapter 5.

In adddition to the Threat Warning Indicator, there are Threat Warning Lights for Lock (LCK) and Launch (LNCH). You will receive a lock warning when your F-16 is being lit-up by enemy radar, and a launch warning when a SAM has been fired. Also, the Master Caution Light is positioned above and to the left of the Threat Warning Indicator. Upon receiving a caution warning, your attention should turn to the Caution light panel.

The RPM Gauge The RPM Gauge gives you an indication of the thrust setting (or throttle position) in percentage of full power. At 60 percent power on the RPM Gauge, the Falcon is at idle power, and producing zero thrust. At 100 percent on the RPM Gauge, the Falcon is at full Military power.

The MIL/AB Indicator Lights The MIL/AB Indicator Lights, located on the far-right side of the cockpit, show whether the engine is in MIL or AB. If the afterburner has been selected, "AB" appears and the display shows the five stages of AB with a series of vertically stacked lights. If the engine is in MIL, "MIL" is displayed.

Other Indicator Lights Several other indicator lights are also present in the cockpit. These lights include the Wheel Brake Light, the Air Brake Light, the Flaps Light, the Autopilot Light, the Start Light, and the Nose Gear Steering/Landing Gear Indicator Lights. These indicator lights are either on or off depending on the status of the mode they represent. For example, when the air brakes are extended, the Air Brake Light is illuminated.

The Left Cockpit Display

The important gauges on the left cockpit display are depicted in Figure 3-4. You get this screen by pressing the 4 key. The following sections cover each display on this screen.

The Back Up Airspeed Indicator The Back Up Airspeed Indicator displays airspeed in tens of knots. This gauge is used if your HUD fails. In the simulation, just as in the real F-16,

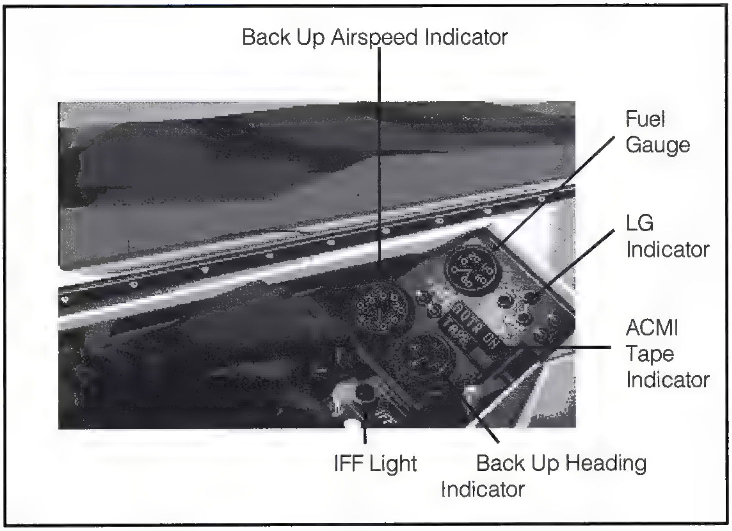


Figure 3-4.

The Falcon 3.0 left cockpit display

you may lose critical systems such as the HUD due to battle damage or routine failure.

The Landing Gear (LG) Indicator The Landing Gear Indicator shows the status of all three landing gear.

The Fuel Gauge The Fuel Gauge is located above the Back Up Airspeed Indicator and shows fuel remaining in hundreds of pounds. The word "Fuel" displayed in the HUD means you are probably close to running dry so think about getting back to the field.

The Back Up Heading Indicator The Back Up Heading Indicator is located to the right of the Fuel Gauge and displays the aircraft heading. This gauge is a backup to the HUD heading scale.

The ACMI Tape Indicator The ACMI (Air Combat Maneuvering Instrumentation) Tape Indicator tells you whether your AVTR (Airborne Video Tape Recorder) is toggled on or off, and how much tape you have left. ACMI will be explained in Appendix B.

The IFF Light When you have a plane targeted, press N; if you have a friendly targeted, you will hear a squawk. If your sound is turned off, check your IFF (Identification Friend or Foe) Light, which will illuminate if you've targeted a friendly.

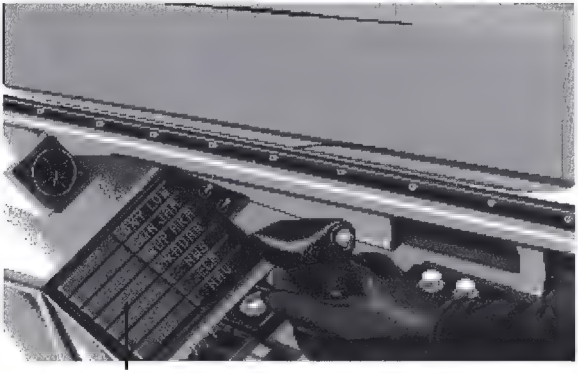
Remember: *Any jet with an afterburner is always short on gas. Monitor the Fuel Gauge continually throughout the flight or you may end up a glider pilot in a war where glider pilots have a very short life span.*

The Right Cockpit Display

You get to the right cockpit display by pressing the 6 key, which should give you the screen shown in Figure 3-5. Notice that it contains the Caution Light Panel. When you get a flashing Master Caution Light in the front cockpit screen, the damaged system will be illuminated on this panel. For example, if your flaps are damaged, you will get a Master Caution Light in the front cockpit, "Bitchin' Betty" (your voice mes-

Figure 3-5.

The right cockpit display with the Caution Light Panel



saging system if you have EMS memory) will yell "Caution!," and the Flaps Light on the Caution Light Panel will light up.

Damaged systems normally occur in Falcon 3.0 due to enemy action. When the bad guys shoot missiles that blow up in your general vicinity, you may end up with a bent airplane. When damage to your jet occurs, you will normally get a Master Caution Light and can reference the Caution Light Panel to find the affected system.

The Stick

Your right cockpit view contains your stick, which is how you control aircraft movement.

Other jets (like the F-15) have control sticks located between the pilot's legs. The F-16 has a *force feel,* side stick located on the right side of the cockpit that only moves about 1/8 of an inch in response to pilot input. The side stick senses pressure and moves the flight controls in response to this pressure. By contrast, the flight controls in conventional aircraft move in response to the physical movement of the control stick. In Falcon you have the option of using the keyboard or a joystick to replicate the function of the F-16 stick. In this book, movement of the stick and control of the Falcon will be explained via the keyboard controls, as shown in Figure 3-6.

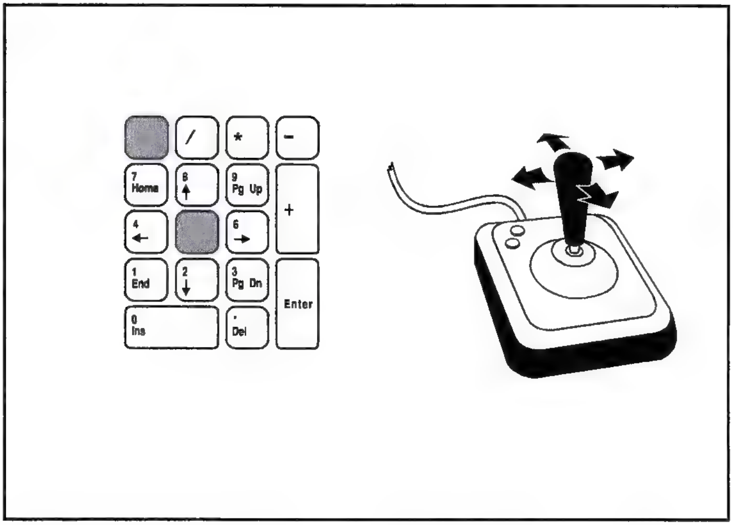
The arrows on the numeric key pad move the stick in the indicated direction. For example, to pull back on the stick, press the DOWN ARROW key. This will apply backward stick pressure and increasing *G* force as long as you hold the key down. When you release a key, the stick automatically centers and you will no longer be commanding stick pressure.

The rest of the keyboard controls work in the same way. The stick movement commanded along with the corresponding *G* force and aircraft nose movement are explained in the following sections.

The F-16 is the only operational fighter with a side stick controller.

Figure 3-6.

The Falcon 3.0 joystick and keyboard controls



The DOWN ARROW/2 Key The DOWN ARROW key commands back stick pressure and higher *G*s, and moves the aircraft's nose up.

The UP ARROW/8 Key The UP ARROW key commands forward stick pressure and lower *G*s, and moves the aircraft's nose down.

The RIGHT ARROW/6 Key The RIGHT ARROW key commands right stick movement and right roll/bank of the aircraft wings.

The LEFT ARROW/4 Key The LEFT ARROW key commands left stick movement and left roll/bank of the aircraft wings.

Actual aircraft maneuvers with these keys will be addressed once you are airborne, later in this chapter.

Takeoff

By now, you're probably impatient to get your butt off the ground. Before you do, let's learn a little take-off technique. Believe it or not, takeoff is the most dangerous non-combat phase of any fighter sortie. The reason for this is that during takeoff the jet is heavy, slow, and close to the ground, which gives you little margin for error in aircraft control. The F-16 has a big motor pushing it, which makes takeoffs relatively easy and safe. Even so, take special care to execute proper take-off procedures in Falcon 3.0 to ensure you don't give the enemy a victory without any shots being fired.

Mission Profile

- Takeoff in an F-16

Mission Objectives

- Learn to take off and perform basic maneuvers in an F-16
- Master basic familiarity with your HUD display

The first step in takeoff is to make sure your landing brakes are on. Press W and watch the WhlBrake light activate.

The first dial you'll use is the RPM Gauge. Your F-16 currently is idle, so press the + key once to throttle up your engines. As you do, watch the RPM Gauge run up to 60 percent.

You can use the - key to decrease throttle. If you pull the power back to 60 percent while airborne, you are commanding zero thrust so the jet will slow rapidly, stall, and crash. The maximum RPM reading is 100 percent, which is full Military power.

Maximum thrust is obtained by using the afterburner. The / key toggles the engine in and out of AB. You can press this key at any RPM level; the engine will accelerate to 100 percent power and the AB will light. Once you have engaged the afterburner with the / key there are five stages or levels of AB that are controlled by the < and > keys. You gain an additional stage of AB with each press of the > key. You can also just hold this key down until all stages of AB are engaged. You lose an AB stage each time you press the < key; by holding it down steadily, you can return to the first stage.

You can leave AB entirely with the / key. Pressing the / key disengages the AB completely and returns the engine to 100 percent MIL power. Pressing the / key a second time will toggle you back into AB. You can monitor the stage and status of the AB by referencing the AB/MIL Indicator. It will show "AB" if the afterburner is engaged, and "MIL" if you are in Military power.

The throttle, the RPM Gauge, and the MIL/AB Indicators are very important in Falcon 3.0. If you use them correctly, you can avoid the tendency to accelerate fully and just race around the combat area with your hair on fire. This may be fun but it will not win you many fights. You must learn to constantly adjust the throttle to fly at the correct airspeed for the tactical situation. This will be covered in Chapter 6, where you learn advanced maneuvering and tactics.

Into the Wild, Blue Yonder

Note: *Don't run your throttle above 65 percent while the brakes are engaged or you'll run the risk of damaging your fighter.*

Now the fun begins. Release your Wheel Brakes by pressing W, and watch your Falcon roll down the runway. Press / to kick in your afterburners, and when the Airspeed Scale reads 15, or 150 knots per hour, gently pull back on your stick. Watch your Pitch Ladder move, and continue pulling back until the Pitch Ladder reads 10 degrees. Like a modern-day Icarus, you're airborne. As soon as you get in the air, press G to retract your landing gear.

Pull back on your stick until the angle of climb on your Pitch Ladder reads between 20 and 30 degrees, and level out when you reach 3,000 feet. Push your stick forward to set your Pitch Ladder at 0 degrees, press / to turn off your afterburner, and enjoy the view.

Caution: *The single biggest mistake you can make in Falcon 3.0 is not maintaining airspeed control.*

You can also reduce speed without reducing your thrust by engaging *Speed Brakes* by pressing the B key. The Speed Brakes, also called "the boards," are high-drag devices designed to slow the jet down. The boards are used frequently in air-to-air combat to kill off excess *smash* (overtaking airspeed) when attacking an enemy aircraft. They are also used in routine non-combat flying to slow the jet down without using the throttle. When you throw the boards out in Falcon, notice the Brake Light in the cockpit and note airspeed deceleration on the Airspeed Indicator. Press the B key to retract the Speed Brakes, and the airspeed will accelerate back to your original speed.

Note: *You shouldn't use your flaps to slow down, since they are really used to gain additional lift at slow speeds. Using them at high speeds will rip them off of your F-16.*

Pressing P will pause Falcon 3.0 so you can reorient yourself, if need be. Fly around and get comfortable while you have the luxury of flying one of the world's premier fighter aircraft in clear skies, and no bogies as far as your radar can see.

Falcon 3.0 Maneuvering

Before you fly any further, let's talk about some fundamental aircraft maneuvering. Maneuvering the jet is nothing more than changing your direction using the stick. This section describes basic flight maneuvers and the necessary stick action.

Toggle the simulation in and out of the Pause mode to read the text and execute the maneuvers in the following sections.

Roll/Bank To roll the wings of the aircraft, press either the RIGHT ARROW or the LEFT ARROW key, or push your joystick left or right, depending on the desired direction of roll. If you press and release the key, the wings will establish a bank angle and stop. If you keep the key pressed, you will continue the roll until you release the key.

Climb To climb in Falcon, first make sure the wings are level with the horizon; roll if necessary to get the wings level. Next press the DOWN ARROW key once or pull back on your joystick. The nose of the aircraft will rise in relation to the horizon. The Flight Path Marker in the HUD will also rise in relation to the Pitch Lines. If you hold this key down, the nose of the jet will continue to climb.

Descend To descend, press the UP ARROW key or push the joystick forward. Again, by holding the key down you will continue to apply nose down stick pressure.

Note: *Real pilots often have to spend dead time in the air while traveling from point to point. You can artificially speed up the passing of time by pressing the TAB key, or press SHIFT-TAB to lock the simulation in Accelerated Time mode. Make sure you go in with your Autopilot on. When you've landed, engage the Wheel Brakes by pressing W, and return to the menu by pressing the ESC key. Select the File option, and click on End Mission.*

Autopilot

Falcon 3.0 comes with the luxury of autopilot. When you're ready to return home to Nellis, engage the autopilot by pressing the A key. Your autopilot will take you home and even land your Falcon. Take special note of what the runway looks like–you'll be finding your way home after training missions later.

Take a breather. You've had a full first day at school, and you're now ready for Lesson 2.

Getting to Know Your HUD

Lesson 2

Load up Lesson 2 and go right to your cockpit. Don't worry about the armaments just yet. If you want, you can take off in your Falcon manually, or you can press A and let the autopilot do it for you. Take your Falcon up to 14,000 feet, and level off or take your autopilot off-line by pressing A. In the next sections, you'll learn about a few more features of your friendly neighborhood HUD, shown in Figure 3-7.

Mission Profile

- Maneuvering Exercise

Mission Objectives

- Enter low-*G* and high-*G* turns
- Learn performance parameters of positive and negative *G* maneuvers
- Continue to learn different HUD displays

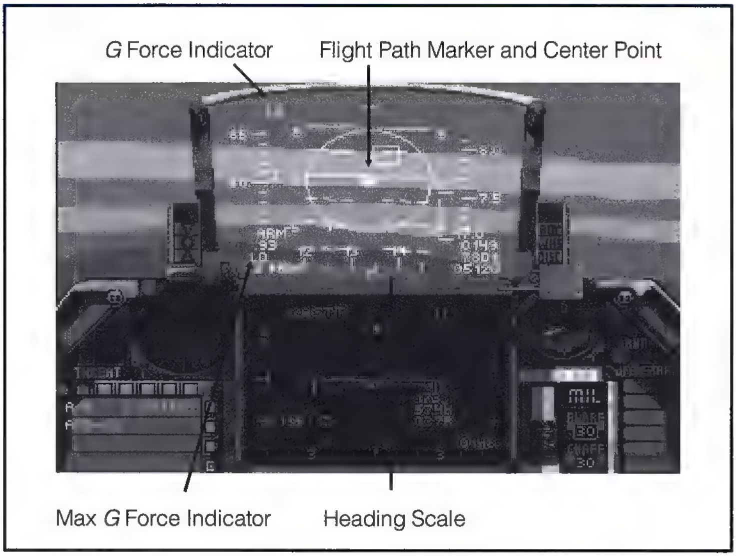
The Heading Scale Located at the bottom of your HUD, the Heading Scale shows your Falcon's current heading. The numbers correspond to tens of degrees, and 0 degrees corresponds to north, 90 is east, 180 is south, and 270 is west. The little vertical line, or hash mark, indicates your exact heading.

The Flight Path Marker and Center Point Your Center Point is located exactly in the middle of your HUD and is used as a point of reference for which direction your Falcon's nose is pointing. The Flight Path Marker shows changes in your flight direction. If you roll left, for example, your Flight Path Marker will move left of your Center Point. As you ease off on your stick, the Flight Path Marker will drift back toward the Center Point.

The G Force Indicator The number in the *G* Force Indicator, located in the upper-left corner of your HUD, shows the current *G* forces you are experiencing.

Figure 3-7.

Several features within the HUD



The Max G Force Indicator The number in the Max *G* Force Indicator, located in the lower-left corner of the HUD above the Weapons Indicator, shows the maximum number of *G*s you have pulled since you hopped into your cockpit.

Low G Turns

Low *G* turns are turns in which the pilot experiences less than three *G*s. These types of turns are used to change aircraft direction when only a small heading change is required or when you do not want to rapidly move the nose. To execute a low *G* turn, press the RIGHT ARROW key and roll the aircraft into a right bank angle of 30 to 60 degrees. The greater the bank angle, the faster you will turn, but do not let the bank angle exceed 60 degrees. You can check the bank angle by looking at the ADI in the cockpit.

Remember: Above 9 Gs, blood flows away from your head and you begin to black out. Below –3 Gs, too much blood flows to your head and you begin to redout.

During the turn, you may need to press the UP ARROW or the DOWN ARROW key momentarily to keep the Flight Path Marker on the 0 Pitch Line and the aircraft level.

You will notice the Heading Scale in the HUD gradually changing headings. Keep turning to the right and when you get to 260 degrees (26 on the Heading Scale), roll out of the turn using the LEFT ARROW key. By the time you get the wings level, the aircraft should be on a heading of 270 degrees. When you have an exact heading you wish to roll out on (during landing for example), you must start your rollout prior to getting to the desired heading or you will overshoot.

High *G* Turns

The ability to execute high *G* turns, and move the nose of the aircraft rapidly, separates the fighters from the targets. This section leads you through a high *G* turn.

At the beginning of this chapter, in "The Mechanics of Flight," you learned about the relationship of bank angles to *G*s during a level turn. This relationship is depicted in Figure 3-2. There are two major differences between executing a high and a low *G* turn in Falcon. In the high *G* turn you use a steeper bank angle and greater back stick pressure. In a low *G* turn you just roll the wings to set a shallow bank angle (less than 60 degrees), and the nose of the jet slowly moves in the direction of the low wing with no back stick pressure required. The following steps are used to perform a high *G* turn:

1. Roll the jet into 75 to 85 degrees of right bank using the RIGHT ARROW key.
2. Apply back stick pressure by pressing the DOWN ARROW key. Keep pressing the key to establish five to six *G*s on the HUD *G* Meter.
3. You will invariably climb or descend if you do not have the perfect bank angle established. If this happens you will notice the Flight Path Marker moving off the 0 Pitch Line in the HUD. To remedy the situation, stop the back stick pressure by pressing the DOWN ARROW key and

adjust the bank angle of the jet right (RIGHT ARROW key) or left (LEFT ARROW key) depending on whether you are climbing or descending.

* If you climb during the turn, increase the bank with the RIGHT ARROW key and then reapply back stick pressure with the DOWN ARROW key and get back to five to six *G*s.
* If you descend during your 5 to 6 *G* turn, decrease the bank angle by rolling the wings left with the LEFT ARROW key back to five to six *G*s.

4. Keep the turn coming and roll out to your original heading of 270 degrees (27 on the HUD Heading Scale). Remember to lead the rollout or you will overshoot the 27 heading.

A high *G* level turn requires a steep bank angle that increases as the *G*s increase. More *G*s generally cause the jet to turn tighter and faster. It is important that you can execute a hard turn, so keep practicing this maneuver until you can do a level five to six *G* turn. Figure 3-8 shows a high *G* turn.

Performing a Loop

Doing a loop in the Falcon is really a simple maneuver that requires some easy stick and throttle input. The following steps describe the procedures for executing a loop:

1. Set the power at 80 percent to establish airspeed at 400 to 450 knots.
2. Descend to 6,000 feet by pressing the UP ARROW key. Establish the Flight Path Marker on the –1 line in the HUD (this equates to ten degrees of dive). When you get to about 6,500 feet (6.5 on the HUD altitude scale), start pulling the Flight Path Marker up to the 0 Pitch Line in the HUD using the DOWN ARROW key. You are now ready

Note: *There is nothing really significant about starting the loop at 6,000 feet. This altitude was chosen so you could practice changing altitude again.*

for the loop. Figure 3-9 shows the correct position prior to commencing the loop.

3. Start applying back stick pressure with the DOWN ARROW key, bringing the nose of the jet straight up and over the top. Figure 3-10 shows the HUD and an outside view of the jet climbing straight up. Notice the position of the Flight Path Marker. *Do not pause in this position.* Keep the DOWN ARROW key pressed and keep the nose moving. Figure 3-11 shows the aircraft in an inverted position on the top of the loop. Notice the horizon at the top of the HUD. Figure 3-12 shows the aircraft heading straight down the back side of the loop.

Figure 3-8.

A high G turn

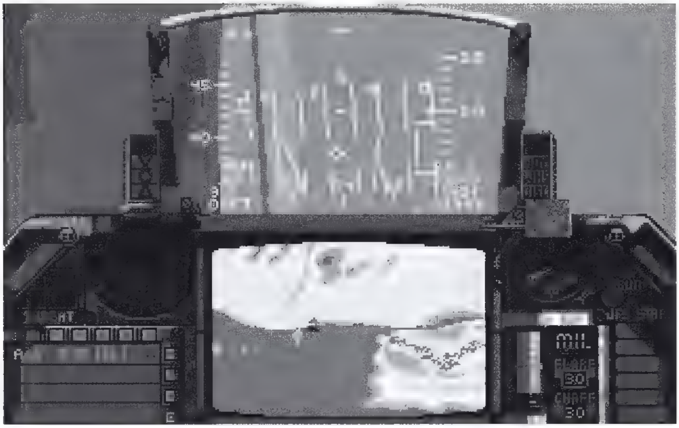
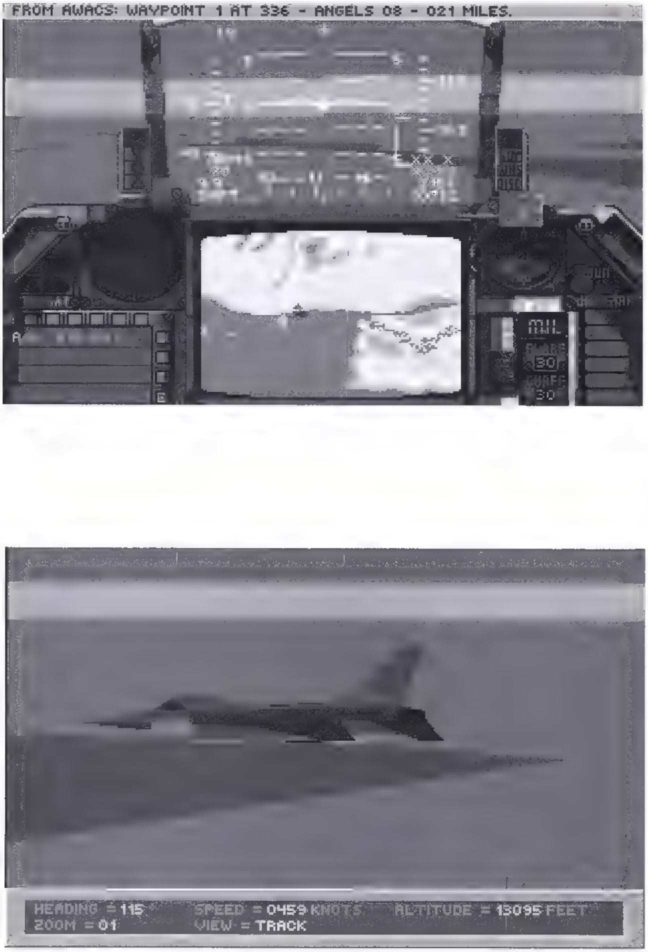


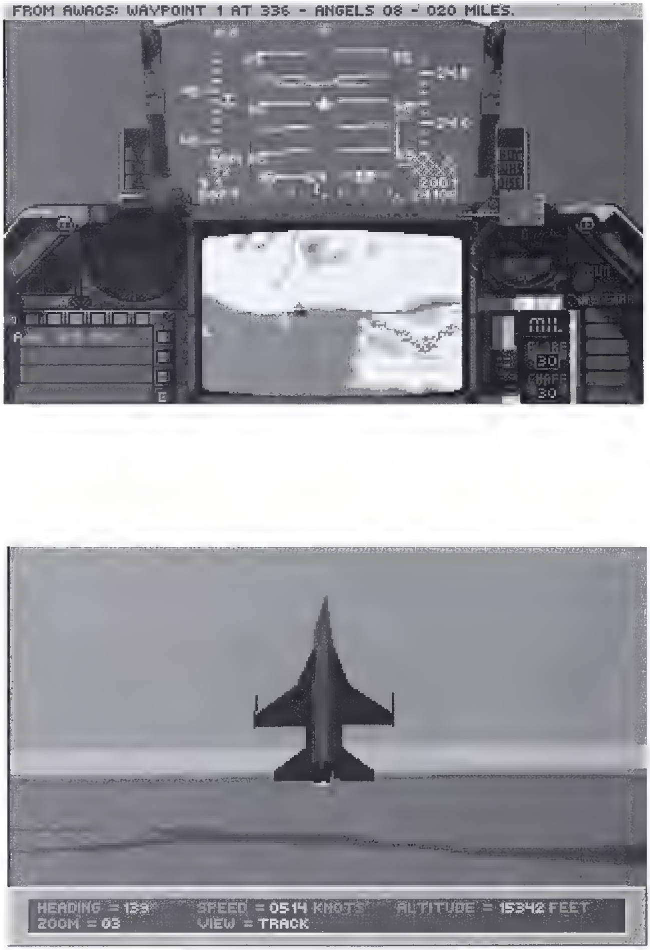
Figure 3-9.

Correct position of the aircraft prior to looping



FROM AWACS: WAYPOINT 1 AT 336 - ANGELS 08 - 021 MILES.

HEADING = 115 SPEED = 0459 KNOTS ALTITUDE = 13095 FEET
ZOOM = 01 VIEW = TRACK



FROM AWACS: WAYPOINT 1 AT 336 - ANGELS 08 - 020 MILES.

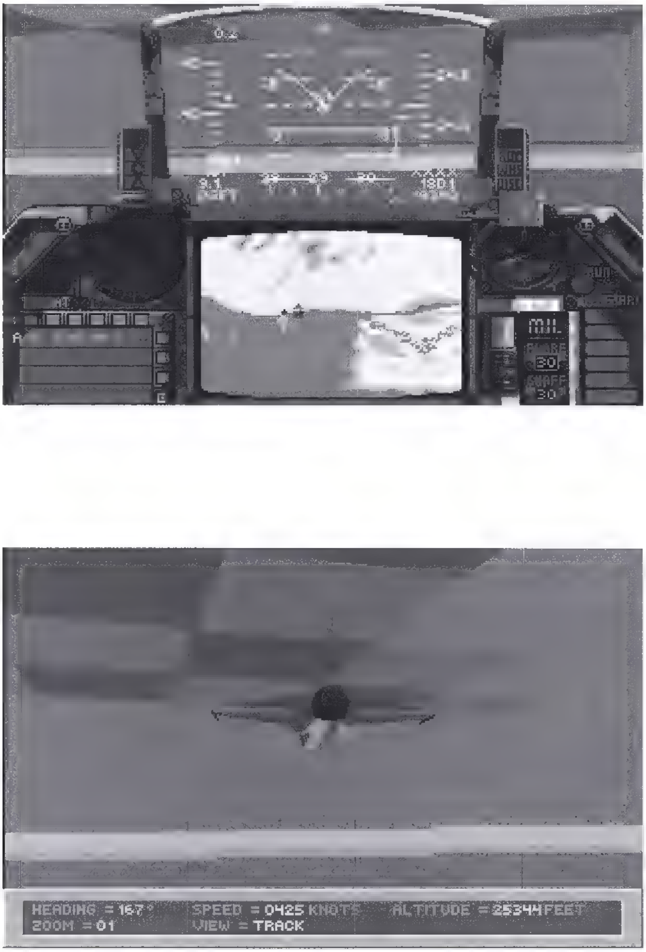
HEADING = 133 SPEED = 0514 KNOTS ALTITUDE = 15342 FEET
ZOOM = 03 VIEW = TRACK

Figure 3-10.

The HUD and an outside view of the jet climbing straight up

Figure 3-11.

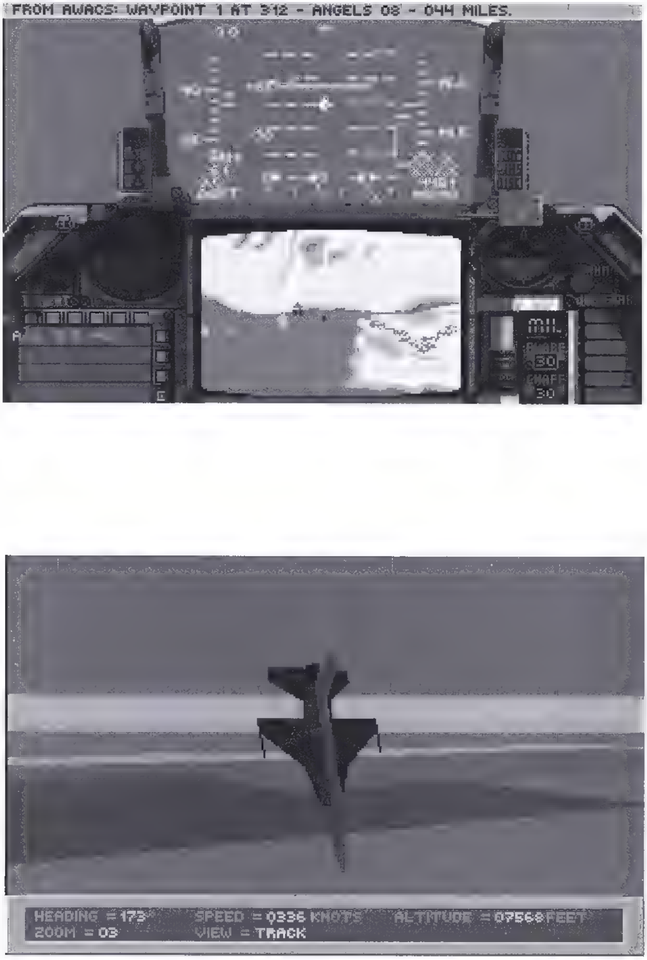
The aircraft in an inverted position on top of the loop. The horizon is at the top of the HUD



HEADING = 167° SPEED = 0425 KNOTS ALTITUDE = 25344 FEET
ZOOM = 01 VIEW = TRACK

Figure 3-12.

The aircraft heading straight down the back side of the loop



FROM AWACS: WAYPOINT 1 AT 312 - ANGELS 08 - 044 MILES.

```
HEADING = 173°     SPEED = 0336 KNOTS     ALTITUDE = 07568 FEET
ZOOM = 03          VIEW = TRACK
```

4. Keep applying back stick pressure until the Flight Path Marker gets ten degrees nose down in the HUD (the -1 Pitch Line). At this point release back stick pressure by releasing the DOWN ARROW key. You should roll out with the same HUD view as shown in Figure 3-9; the Flight Path Marker in the HUD should be on the 0 degree Pitch Line. Practice doing loops to get the feel of maneuvering the jet vertically. After you are comfortable doing loops, move on to the next section.

Positive and Negative G Dives

Negative *G*s are anathema to the fighter pilot. Whereas you experience positive *G*s when you accelerate by pulling the stick back, you experience negative *G*s when you accelerate by pushing the stick forward–like dropping down in a roller coaster. You can experience negative *G*s in Falcon if you bring your airspeed up to about 630 knots per hour by kicking in your afterburners (by pressing /) and increasing the staging by pressing > twice. Nose your Falcon down; you'll begin to redout right away–not very convenient while trying to shake a MiG on your six.

Yet you can perform the same maneuver and pull positive *G*s, for which the human body has a higher tolerance. To do this, bring your Falcon back up to 14,000 feet. Bank your Falcon left until you are upside down. Pull back on the stick; you are now diving towards the ground. Bank to the right and pull back on the stick until you level out. This is a much more efficient way of executing the same maneuver (unless, of course, you enjoy having all your blood surge into your head).

Remember: *The F-16 is three times more maneuverable in positive Gs than in negative Gs.*

Your Views from Above

Now is also a good time to familiarize yourself with the various views of, or from, the fighter in Falcon 3.0.

The Forward View You are already familiar with the most important view, the forward view from the cockpit. You display the forward view by pressing 3.

The Left View Pressing 4 displays your left view, which displays your Fuel Gauge, Landing Gear Indicator, Back Up Heading Indicator, Back Up Airspeed Indicator, IFF Light, and ACMI Tape Indicator. See Figure 3-13 for an example of the left view.

The Right View Pressing 6 will get you to the right view, shown in Figure 3-14, where you'll see your hand on the stick, a mission clock, and the Caution Light Panel. The Caution Light Panel will tell you about any damage your Falcon has sustained. Neither the left nor right view is particularly useful when engaging the enemy.

Figure 3-13.

The left view of the Falcon cockpit

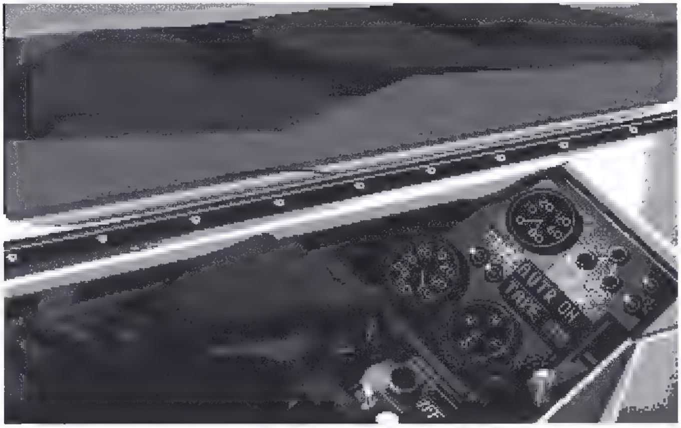
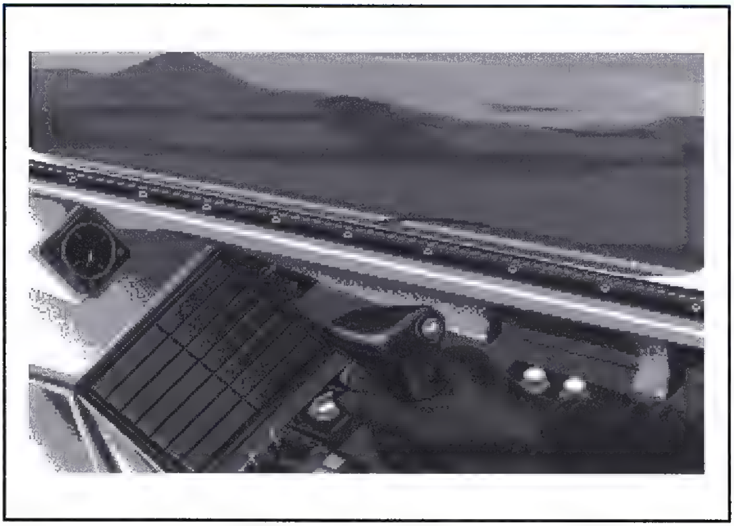


Figure 3-14.

The right view of the Falcon cockpit



The Six O'Clock View Pressing 5 will show you your six, or rear view, as shown in Figure 3-15. With this view, you can check out your wingmen or bogey on your tail.

The Up View Pressing U gives you the up view, which is like looking straight up from your cockpit. See Figure 3-16 for this perspective.

Cockpit Scrolling An exceptionally useful feature in Falcon 3.0 is *cockpit scrolling*. Pressing SCROLL LOCK gives you the ability to look up or down in left, right, rear, or forward view. This is especially useful in combat while looking out your forward view, which is shown in Figure 3-17.

The first flight simulator, patented in 1929, was called The Link Trainer. Designed as a replica of an airplane, with controls and instruments, The Link Trainer was attached to a mechanical crab that traced a path over a large scale map in order to represent the speed and heading of the craft.

Figure 3-15.

The rear view from the cockpit

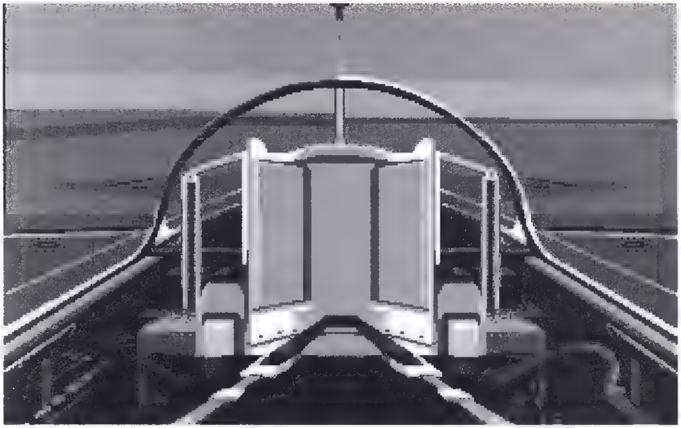


Figure 3-16.

The up view is useful for finding targets when in a bank

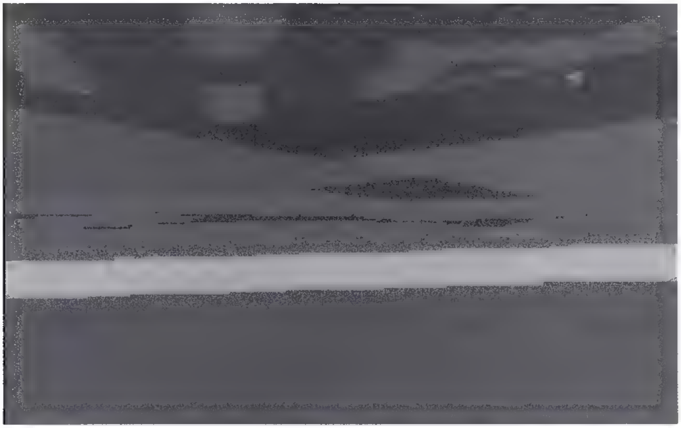
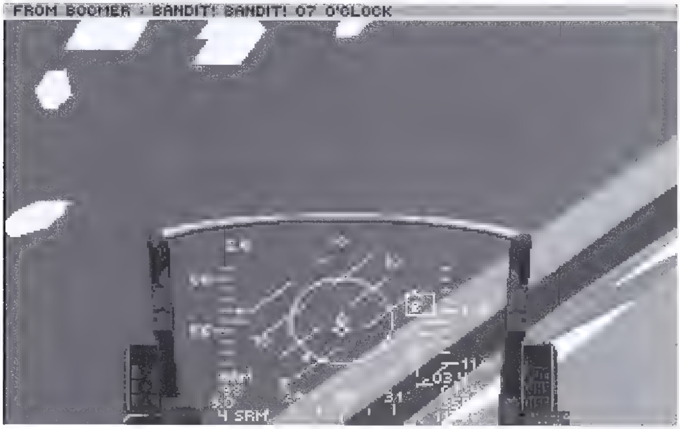


Figure 3-17.

Using SCROLL LOCK to look up from your forward view



FROM BOOMER : BANDIT! BANDIT! 07 O'CLOCK

The beauty of Falcon 3.0 is that it is a flight simulator—you can see things that a real fighter jock could not see from the cockpit of a real F-16, such as external views of your F-16 gliding through the sky. An *external view* is like having a flying camera alongside your aircraft; you are the director, setting camera angles and panning movements. Your external views come equipped with handy status boxes, which tell you some basic information, along with your zoom indicator. Press F1 to zoom in and F2 to zoom away from your Falcon. You can rotate horizontally clockwise by pressing F3, and counterclockwise by pressing F4. SHIFT-F3 and SHIFT-F4 will rotate your camera around your F-16 vertically. Pressing CTRL-F3 and CTRL-F4 will give you a finer degree of control over rotation so you can better see specific areas of the outside of your Falcon.

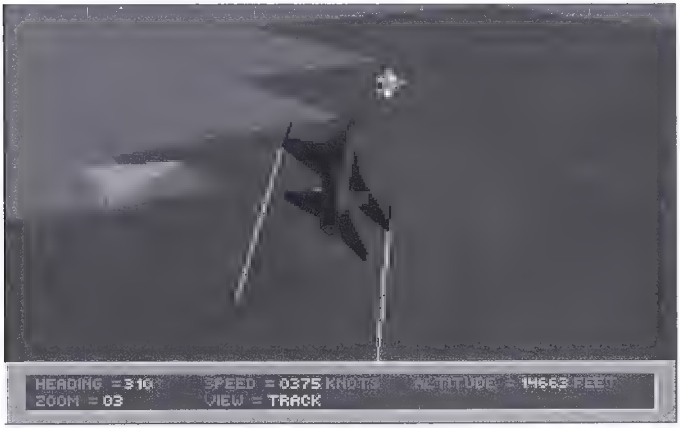
The Track View An external view you'll probably use often is track view, as if a camera was trailing behind your aircraft.

In combat, you'll be able to see your F-16 and any bogey you've locked onto. See this by pressing 9. Your view should look like Figure 3-18.

Satellite and Ground Views The satellite view shows your F-16 from directly above; the ground view shows your F-16 from directly below. Obviously, these views won't do much for you in combat. Press 1 for satellite view, 2 for ground view. Your screen should look like the views shown in Figure 3-19.

The Wingman View Until the enlightened day when women are allowed into combat flying (and it's not far off), your flying mates are referred to as wingmen. Lesson 3 comes equipped with a wingman. Pressing 7 will allow you to see from your wingman's perspective. Your screen should look like Figure 3-20.

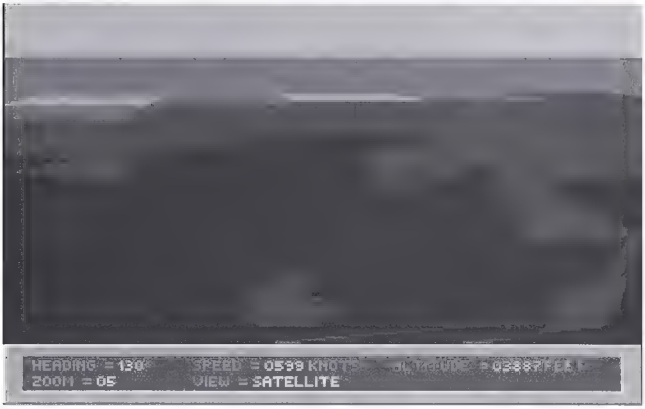
Figure 3-18.



Track view looks like it comes from a camera trailing the aircraft

Figure 3-19.

Satellite and ground views show the aircraft from directly above or below. They can be changed by manipulating the view keys



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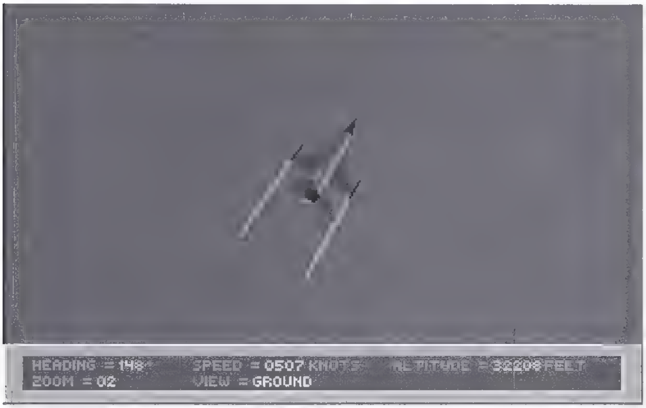
ZOOM = 05           VIEW = SATELLITE
```



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HEADING = 148°      SPEED = 0507 KNOTS    ALTITUDE = 32208 FEET
ZOOM = 02           VIEW = GROUND
```
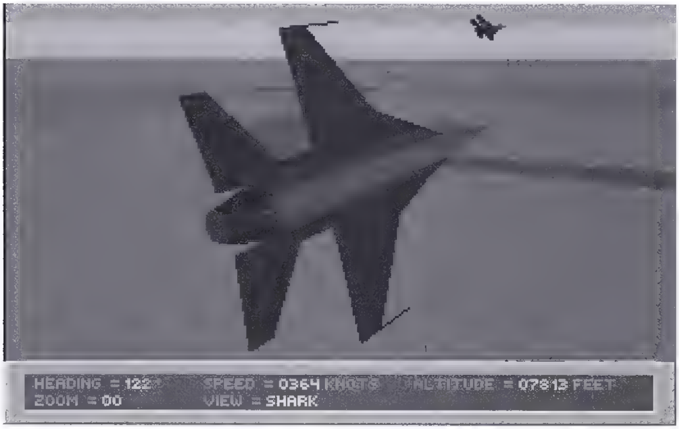



```
HEADING = 122°      SPEED = 0364 KNOTS    ALTITUDE = 07813 FEET
ZOOM = 00           VIEW = SHARK
```

Figure 3-20.

The wingman's perspective

The Chase Plane View Pressing 0 will put your camera in a chase plane that will follow your movements, with a bit of lag time. It is the most theatrical (except maybe for the missile view) of all the external views. You can see an example of the chase plane view in Figure 3-21.

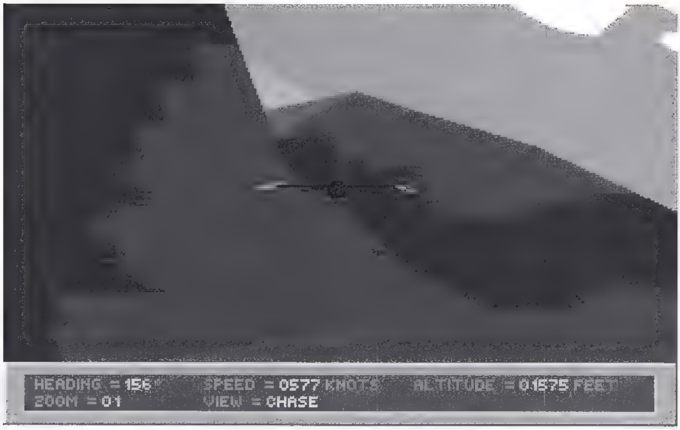
Missile, Enemy, and Target Views As their names suggest, missile, enemy, and target views are used when you're in combat. Pressing Q toggles among them.

The enemy view shows you the point of view from an enemy plane or ground site; the target view gives the perspective from behind other enemy planes. See Figure 3-22 for views from your missile and air enemy.

The Padlock View The padlock view is extremely helpful in combat; it essentially simulates the 360 degrees of visibility

Figure 3-21.

The chase plane view



available to an F-16 pilot due to the F-16's unusual canopy design. Press 8 for this view, which is shown in Figure 3-23.

Have you had enough excitement for one day? Press A to engage autopilot and take your bird home, and watch it land with your track view by pressing 9.

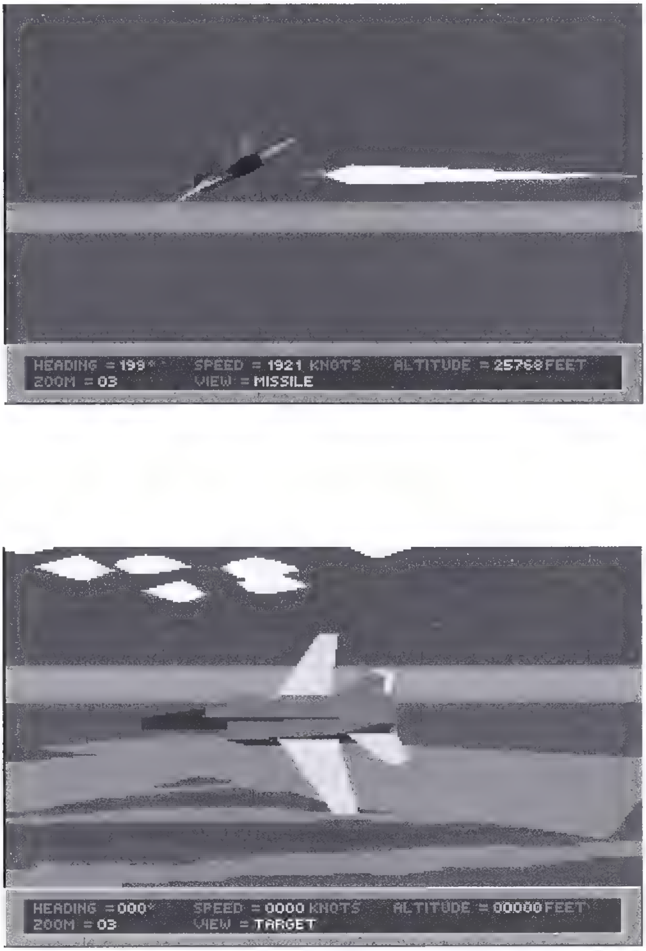
Touching Down

Now comes one of the most daunting tasks of flying Falcon 3.0. Though it may not seem so, landing is second only to takeoff as the most dangerous non-combat phase of flight. A jet is not as "heavy" landing as it is taking off. However, when flying a simulator, it's hard to discern the feel and weight of the F-16 when landing.

I (Pete Bonanni) spent about three years teaching pilots to land the F-16 and in that time I have seen the landing

Figure 3-22.

The views from your missile and air enemy



HEADING = 199° SPEED = 1921 KNOTS ALTITUDE = 25768 FEET
ZOOM = 03 VIEW = MISSILE

HEADING = 000° SPEED = 0000 KNOTS ALTITUDE = 00000 FEET
ZOOM = 03 VIEW = TARGET

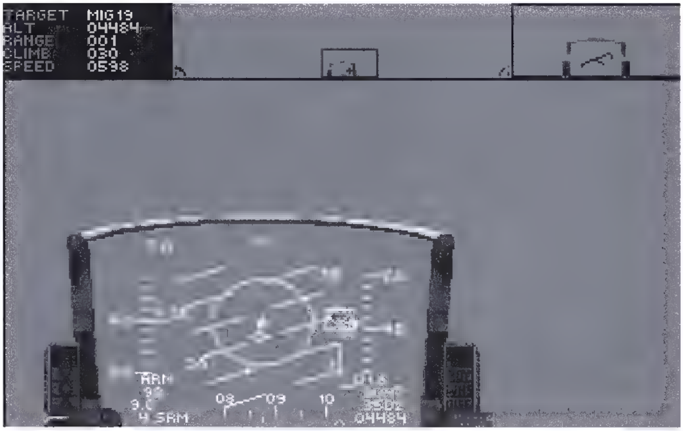


Figure 3-23.

The 360 degree Padlock view is extremely helpful in air combat

runway from a number of interesting–and sometimes less than enjoyable–perspectives.

One day I was in the bar after the flying was over swapping "war" stories with a buddy of mine, Slick. Slick started the conversation by telling me that he had seen a very interesting sight while out at mobile. (*Mobile* is a small elevated glass building located at the end of the runway where instructors observe student landings.) Slick was reading magazines and watching airplanes land when he saw an F-16 coming in, steep on glide path, about two miles out on final approach. This interested him, so he put down his copy of *Readers' Digest*, and focused his attention on what appeared to be a plumber trying to land an F-16.

Note: *During the recent Iraq conflict, there was much talk about how war has become depersonalized, since much of that war was fought without seeing the enemy. This is especially true in modern air combat, when an Air-to-Air missile can lock-on to a target miles away. If you use the missile view during weapons lessons, you'll see up-close and personal how you've just killed the enemy. However, a combat pilot has no time for such philosophical debates during a dogfight.*

As the jet approached he saw it was a two-seat B model. This meant there was an IP (instructor pilot) in the pit (back seat) of the jet, so he relaxed a little. As it got closer, though, the landing went from bad to worse, and the jet started dropping like a rock toward the runway. A hundred feet above the runway, the pilot went to full AB to arrest his descent but it didn't help. Slick grabbed the radio to tell the pilot to go around but it was too late. The jet hit like a ton of bricks and bounced in the air, banked 90 degrees at about 50 feet off the runway, and lumbered back into the sky. Slick said he was so stunned and scared, he never even made a radio call.

During this tale I just nodded my head and acted interested and surprised. When he was finished with the story I just drank down my whiskey like a good pilot, mumbled something about being glad I wasn't in mobile, and headed out the door. Unfortunately I had an even better view of the whole thing than Slick did because I was the IP in the pit during that landing. I let the student stray a little too far out of safe landing parameters and when I finally took control of the airplane the only thing that stood between our sorry behinds and a crash landing was God and that big Pratt and Whitney engine. I never did tell Slick that I was the IP in the back seat of that jet, but I think he already knew. The lesson I learned that day was: *don't ever get complacent in the landing pattern.* Hit your parameters or go around and try it again.

This lesson also holds true in the simulation. The ultimate objective in Falcon 3.0 Air Combat is to make the number of successful landings match the number of takeoffs. The next section will help you master the difficult art of landing the Falcon. It is a real shame to destroy your target, and survive the mission, only to get morted (killed) trying to put the airplane back on the runway.

There is an infinite number of landing techniques possible in the simulation, and the following is only one of them. If you do not already have your own technique for landing the jet, these steps will help you put the Falcon safely on the runway. Pause frequently by pressing P during the landing sequence to make sure you are staying up with the jet. If you don't want to learn the art of landing, you can always have Mr. Autopilot do the job for you.

Load up Lesson 4 from Red Flag to begin your landing lesson. You'll also learn a few new features of your HUD. You'll start up in the air, so press the \ key; your HUD will switch to the ILS (Instrument Landing System) mode.

Lesson 4

The letters "ILS" will illuminate in the lower-left corner, and the circle in your HUD will be replaced by notched horizontal and vertical bars. See Figure 3-24 for a view of the ILS HUD.

The ILS HUD

The vertical bar in the ILS HUD is the Localizer Deviation (LD) bar, and the horizontal bar is the Glide Slope Deviation (GSD) bar. The LD bar measures your deviation from the center of the runway. If you align the bar in the center of the HUD, you're on target for the tarmac. The GSD bar measures your vertical angle to the runway. The GSD bar should be in the center of the HUD to ensure that your approach is at the proper angle; if it is below center, you are coming in too high. If the GSD bar is above center, you are coming in too low.

The Angle of Attack System

The AOA (Angle of Attack) System consists of two indicators, the AOA Indexer and the AOA Indicator. They are used to display your F-16's angle of attack. The Indexer uses arrow prompts while the Indicator uses a number.

The AOA Indexer The AOA Indexer is located to the left of your HUD. If the top arrow pointing down is illuminated, your AOA is too high. Raise your airspeed by either accelerating or nosing your bird down. If the bottom arrow is illuminated, your AOA is too low. Lower your airspeed. When the center circle light comes on, you're on target.

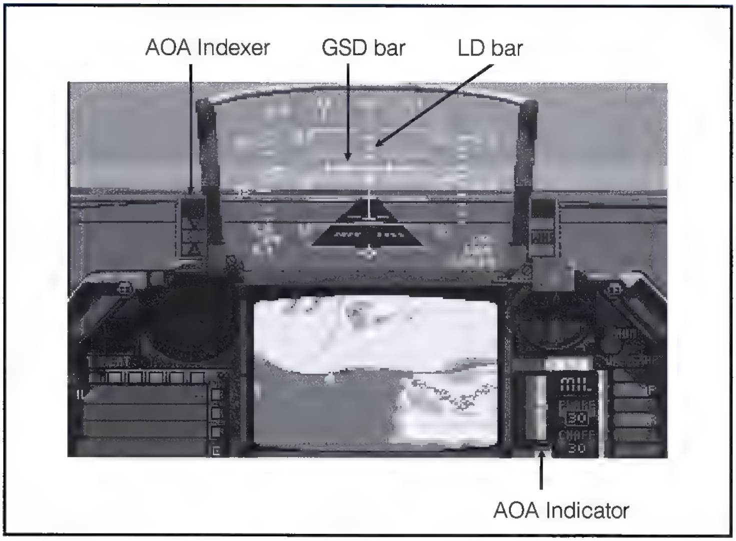


Figure 3-24.

The ILS HUD. Note the position of the vertical LD bar and the horizontal GSD bar

The AOA Indicator The AOA Indicator is located to the right of the radar display, below the RPM Gauge. If the indicator is red, you have a negative AOA. The light-blue indicator means you have a positive AOA. Your AOA should be between positive 10 and 13 degrees. If your AOA is below 10 degrees, the Indexer arrow will point up. If your AOA is above 13 degrees, the Indexer arrow will point down. Well, we're gonna' run through it anyway. Here we go.

1. Lesson 4 starts you off about eight miles due north of the landing strip. Get into your ILS HUD by pressing the \ key and bring your Falcon around to a heading of approximately 180 degrees, but check your waypoint caret and your LD bar to determine your exact heading. The number "8D2" should be in the lower-right corner of your HUD. This means you are eight miles from waypoint 2, your landing field.

2. The jet should be heading approximately 180 degrees. Press C to check out the Map mode. Next comes the landing pattern. Cut the power back to stabilize your airspeed at 200 knots.
3. Descend and level off at 3,000 feet.
4. When you are five miles from the field, descend to 2,000 feet. Extend the landing gear by pressing the G key. Confirm the gear are down by pressing the 4 key and checking for gear lights in the Landing Gear Indicator or by checking an external view.
5. Extend the flaps by pressing the F key. The Flaps Light in the front cockpit screen will illuminate when the flaps are down.
6. When you get about four miles from the field, start a gentle descent by putting the Flight Path Marker slightly below the 0 Pitch Line in the HUD. Monitor the exact altitude readout in the bottom-right corner of the HUD so you don't go below 1,000 feet until you have the runway in sight.
7. Adjust the RPM to slow down to between 150 and 200 knots. As you gain proficiency, strive to land at 150 knots. This will make stopping the jet easier and gain you style points with observers sitting in the mobile (it looks more dramatic to land slowly).
8. Keep following the headings of the computer and make small bank angle corrections to get on the correct heading. This is where PIO (Pilot Induced Oscillation)–in other words, over-controlling your jet–is most apt to occur.
9. When you have the field in sight, place the Flight Path Marker about one quarter of the way down the runway and keep coming down. The closer you get to landing, the smaller the pitch and bank corrections you'll need to

Remember: *If your landing isn't proceeding according to plan, DON'T be afraid to abort your landing and try again. Increase your throttle to 80 percent and pull up. Better to try again than to end up embarrassing yourself in front of any watchers in the mobile–or worse.*

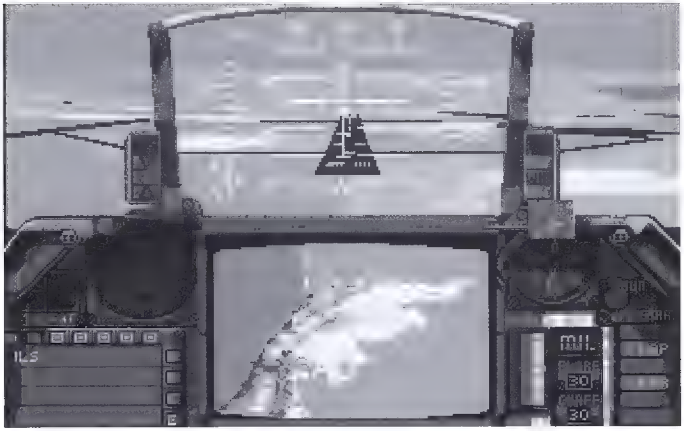
make. Figure 3-25 shows the Falcon one mile from the field with the runway in sight.

10. Figure 3-26 is the same landing sequence with the jet lined up on the field. The altitude is now 56 feet and the Flight Path Marker is one quarter of the way down the runway. When the landing picture looks like Figure 3-26, retard the throttle to idle and extend the Speed Brakes (press the B key). In this picture the jet is lined up for landing. Use the rudder keys ([and]) to fine-tune your horizontal orientation with the landing field.

11. Just before touchdown, keep your AOA at not less than 8 and make sure airspeed is between 160 and 190 kph. At touchdown the nose will drop and the altitude will read zero. When this occurs, reduce throttle and push your nose down; when you come to a stop, apply the Wheel Brakes (with the W key) and steer toward the

Figure 3-25.

One mile from the field with the runway in sight



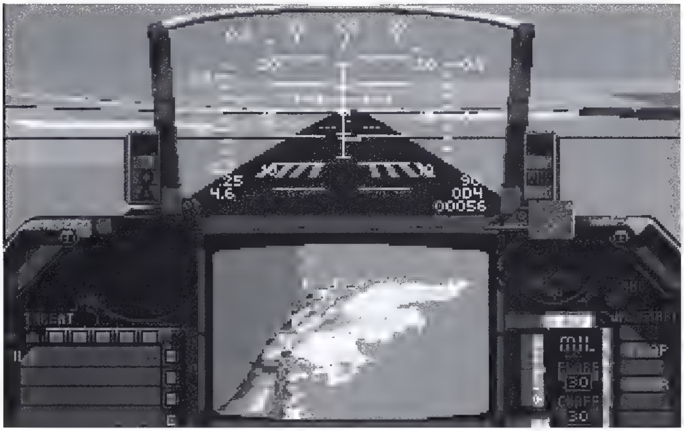


Figure 3-26.

Lined up, approaching field

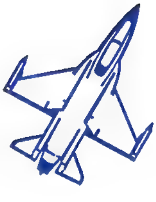
center of the runway using normal aircraft controls. Let the technos take care of your bird while you unwind.

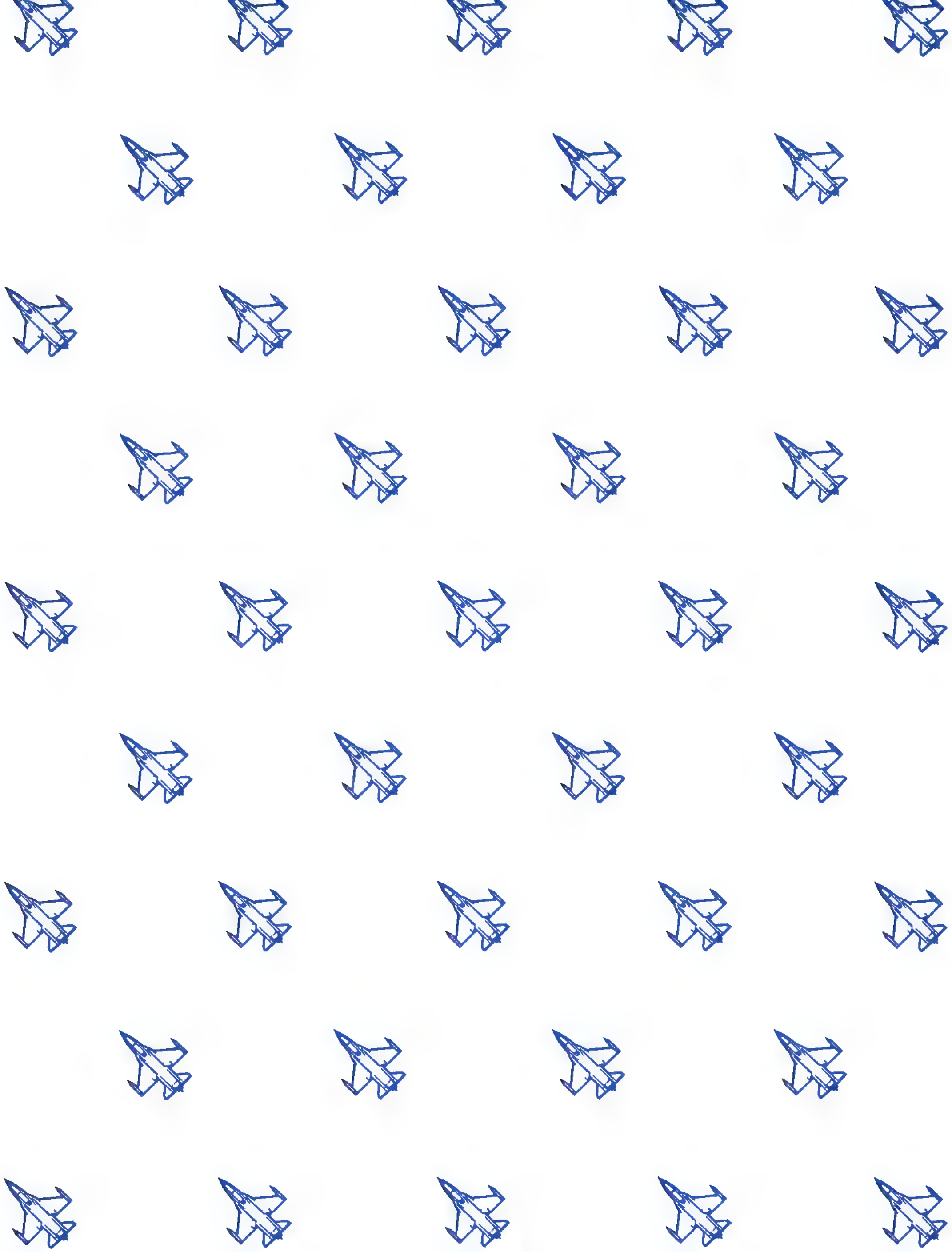
Keep practicing and don't be afraid to develop your own landing technique after you've mastered the textbook approach.

Mission Debriefing

Well, nobody said it would be easy. If you want to do something easy, get up from the computer and stick a quarter in one of those arcade machines. It will definitely take you a few go arounds in the landing circuit before you can safely bring your bird to roost.

This training sortie reviewed the basics of flying the jet. Once you get a general idea of how to fly, you can start fighting. The next chapter covers weapons. Once armed with weapons, you will seek out and engage the enemy. If the weapons chapter is the one you've been waiting for, keep in mind that old Chinese proverb: Beware of what you wish for, for you may get it.





CHAPTER

4

WEAPONS

"Mamas don't let your babies grow up to fly fighters, don't let 'em shoot missiles and drop bombs on trucks, make 'em be doctors and lawyers and such..."

–Fighter pilot adaptation of a famous Willie Nelson song

The scenario was standard for a Battlefield Air Interdiction mission. An enemy tank division was moving up to reinforce a combined arms division that was locked in combat with U.S. forces along the *forward line of troops (FLOT).* In addition to the standard *surface-to-air missile (SAM)* threat, the enemy had air cover over the advancing division. Our job was to attack the forward elements of this tank division with Maverick missiles. The real target for the mission was a collection of burned-out tank hulks to the north of Nellis Air Force Base. The real threat for the mission was in the form of two Navy Aggressor A-4s simulating MiGs. I (Pete Bonanni) was flying with a guy named Skip on a fun-filled, action-packed Weapons School sortie. (The Weapons School is a very demanding four-month course in F-16 Weapons and Tactics, which I will describe in more detail throughout the book.)

On this sortie, Skip and I were both carrying live Maverick missiles. My recent poor performance on an earlier live weapons mission gave me extra incentive to get that coveted big *E* on this ride. The big *E* was a perverse Weapons School term. When you landed from a Weapons School ride, the Instructor at the Duty Desk in the Squadron filled out a form. On this form you signed in, filled out your flight time, and noted whether or not the sortie was "effective." An effective sortie meant you passed the ride and got an *E* on the form; a non-effective sortie or *NE* meant you flunked. When you got back from a Weapons School mission, you always nonchalantly sauntered over to the Duty Desk before the debrief to check the sign-in form for the big *E*. There were a few times when you definitely knew you had passed or failed the ride but most of the time it was a toss-up.

The mission was going smoothly as we approached the tank hulks. I had two bandits on my radar in trail formation, about five miles from the target area. The A-4 does not have air-to-air radar so the two Navy aggressors were groping around blind trying to find us. Using our radar "grip," we easily swung around to their six o'clock unobserved and attacked them with AIM-9Ls (simulated of course). After quickly "killing" both of them, we continued our attack on the tanks. The plan was for me to attack the farthest tank in the column and for Skip to attack the closest one. I called up the Maverick missile and started my attack from about three miles out.

The Boeing B-52 Stratofortress can carry the heaviest bomb load of any operational bomber plane: up to 70,000 lbs.

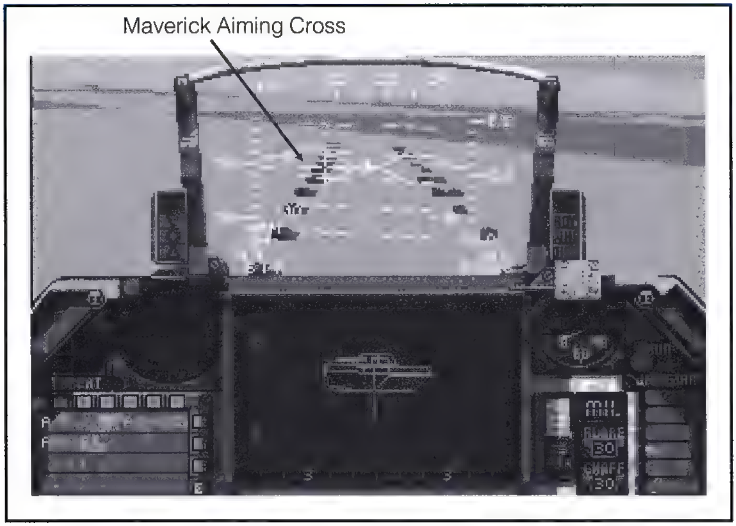
The air-to-ground modes in the F-16 can be accessed by the pilot with the Dogfight/Missile Override thumb switch. This switch is located on the throttle and has three positions: forward, aft, and center. The forward and aft detents are air-to-air weapons modes. The center detent can be programmed by the pilot to call up air-to-ground weapons. On this ride I had the Maverick missile programmed to come up when I selected the center position on the Dogfight/Override switch.

Upon entering the Maverick mode the radar screen is transformed into a TV picture that shows a view from the Maverick missile. This TV picture has an Aiming Cross located in the center that can be controlled by the pilot. To execute an attack, you point the Aiming Cross in the HUD at the target and look at the TV picture to lock-on (see Figure 4-1).

You lock-on to the target by *slewing* (or turning) the Aiming Cross located in the radar scope (now a TV picture) with the Cursor/Enable button, which is also located on the throttle. You use this button to move the Aiming Cross over the target and lock-on. Once you lock-on, the Cross will stabilize on the target and you can fire the missile. What makes

Figure 4-1.

Target acquired



this type of attack sporting is the ground rushing up at you at about 800 feet per second while you are trying to look into the radar and lock-on to the target. Of course, "if you're afraid / you'll have to overlook it / because you knew the job / was dangerous when you took it." These words to the old Super Chicken cartoon are a good thing to keep in mind during most Maverick attacks in the F-16.

I picked up the tank column and rolled in on the end tank in the column. The Maverick locked on to the tank, and I quickly checked the lock and hit the "pickle" (release) button. The plane shuddered slightly as the Maverick rocket motor ignited and the missile left the launch rail. The jet was instantly covered in white smoke as 500 pounds of supersonic metal headed for the target. I immediately broke left to clear my six o'clock and gain sight of my wingman, and I gained a visual on Skip just as he fired his missile. We quickly got back in formation, and on the way out of the target area we again picked up the aggressors on radar. We were playing "30-second kill removal" so these guys had "come back to life" and were looking for us. This was a mistake. We had a good radar grip at ten miles and for the second time attacked them unobserved.

After killing both of them again, we exited the area and headed back home. I figured I was a shoo-in for the big *E*. After landing, we went back into the squadron to sign in and debrief, and, sure enough, when I checked the sign-in forms, there it was—the big *E*. It may have only been black ink written on paper, but it appeared to glimmer like a jewel.

During the debrief we reviewed the aircraft VCR tape to check our missile shots. The F-16 has a VCR that can film the HUD or the radar scope. The pilot selects which one to record and turns the camera on. The Maverick missile gives you a TV picture presented in the radar scope of what the seeker head

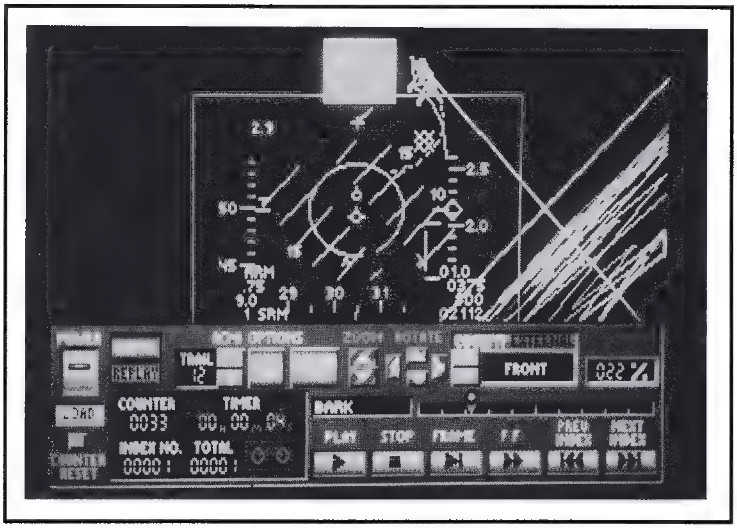


Figure 4-2.

ACMI (Air Combat Maneuvering Instrumentation) of the missile is seeing. You can record this picture (shown in Figure 4-2) and review it after you land, much like the ACMI allows you to do in Falcon 3.0. (Refer to Appendix B for more about ACMI.)

I put my tape in the VCR and watched my attack. I saw the tank come into view and saw my maverick lock-on to it. The lock-on was very unstable, which I had not noticed during the flight. In a good Maverick lock-on the Aiming Cross is solid and stable on the target. In a bad lock the Aiming Cross is jittery and moves in relation to the target.

As the tape continued I was dumbfounded when the Maverick Aiming Cross jumped from the tank I was aiming at to a nearby bush. Just a split second after this happened the screen went blank, indicating that the missile had been fired. I looked over at Skip, smiled feebly, and said, "Whoops." I never noticed that the missile had transferred lock to the bush, and I didn't watch the missile hit the ground because I was breaking to clear my six o'clock.

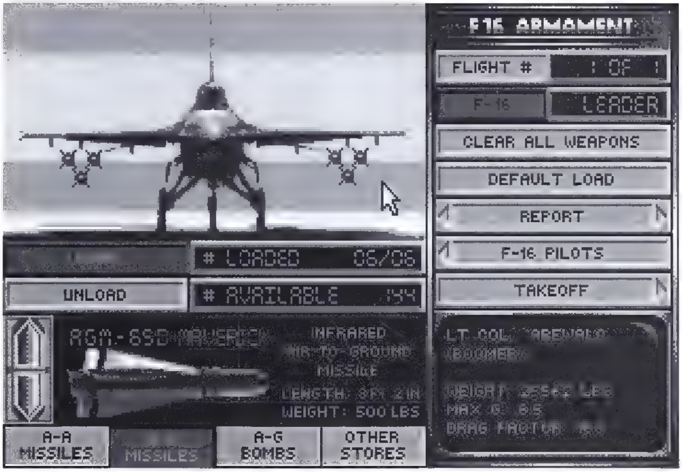
Skip didn't look too concerned but he did say, "Maybe I didn't make the objective of this flight clear enough in the briefing. We were out there to kill enemy tanks, not shrubbery." He found his own wit to be irresistible, and was so amused by the whole thing that he invited the entire squadron to come into the debriefing room to watch me kill the bush. "Well, there goes the big *E*," I thought. The "peanut gallery" all piled into the room and got a good laugh at my expense. When they finally cleared out of the briefing room and we finished the debrief, I ended up passing the ride. (Well, I did lead a mission where we killed four "MiGs" and were one out of two for Maverick hits.) Skip said my performance was "indeed average." I think I must have caught him in an exceptionally charitable mood that day and was thankful to escape with the big *E*, no matter how average my flight.

The Maverick missile I fired that day (shown in Figure 4-3) was designed to solve specific tactical problems. The modern battle tank is a tough target to kill. The Maverick is not perfect, but it does provide the F-16 with an effective tank-killing weapon.

The Maverick, like a number of other weapons carried by today's fighters, is highly accurate and lethal, but difficult to use and relatively expensive. Because of the expense, these weapons, however effective, are limited in quantity. The F-16 overcomes the potential problem of running out of these "silver bullet" weapons by having a *smart* weapon delivery system. A smart delivery system ties together the aircraft radar, navigation aids, and cockpit displays to give the jet the capability to deliver *dumb* iron bombs with great accuracy (as in the Israeli raid on Osirak).

Figure 4-3.

The AGM-65 Maverick



# LOADED 06/06

# AVAILABLE 84

AGM-65D MAVERICK

WEIGHT: 500 LBS

Nowhere was this more effectively demonstrated to the world than in the Kuwait conflict. Never before was such a display of lethal weapons delivered with unerring accuracy against all types of strategic targets. The F-16, with its flexible air-to-air and air-to-ground payload, was an active participant in the coalition forces. The air-to-ground munitions carried by the F-16 are a balance of smart and dumb weaponry. (Air-to-ground weapons are covered later in this chapter, and Chapter 7 fully covers air-to-ground combat.)

Survivability

Today's fighter aircraft must be able to survive in the air battle, and having a lethal weapon system is a large part of survivability. Modern combat is fought with accurate and deadly firepower. Use of the electromagnetic spectrum for sensors and weapon guidance has produced a battlefield featuring *bull's-eye weapons*. Single targets are now engaged and destroyed with single, highly accurate weapons, rather than volleys of inaccurate projectiles. In this environment, the ability to minimize your exposure to the threat and to engage targets with accurate and lethal weapons is essential. In fighters, you minimize your exposure to threat systems by using speed, stand-off weapons (silver bullets), low radar, IR (infrared), and visual profiles. This is part of the *survival* side of the air battle equation.

Another part of survival is the use of countermeasures such as electronic jamming, chaff, and flares to negate enemy threat systems. (You'll learn more about jamming, chaff, and flares in Chapter 5.)

Lethality

The other side of the air battle equation is the *lethality* of your own weapons against the enemy. Here you must have an on-board weapons suite capable of delivering accurate, destructive firepower. Modern fighters such as the F-16 are *weapon systems*. These aircraft contain avionics and weapons that, together with the aircraft's flying characteristics, make up the weapon system's capability. The F-16 is a lethal weapon system that can deliver both smart and dumb munitions with accuracy.

Air-to-Air Weapons

Falcon 3.0 re-creates the F-16 weapon system and the air combat environment in which it operates. In the simulation, the Falcon can be armed with a variety of weapons. The following sections will teach you the characteristics of these weapons, and their associated HUD symbology, but you won't learn actual employment techniques until Chapter 6.

The Gun

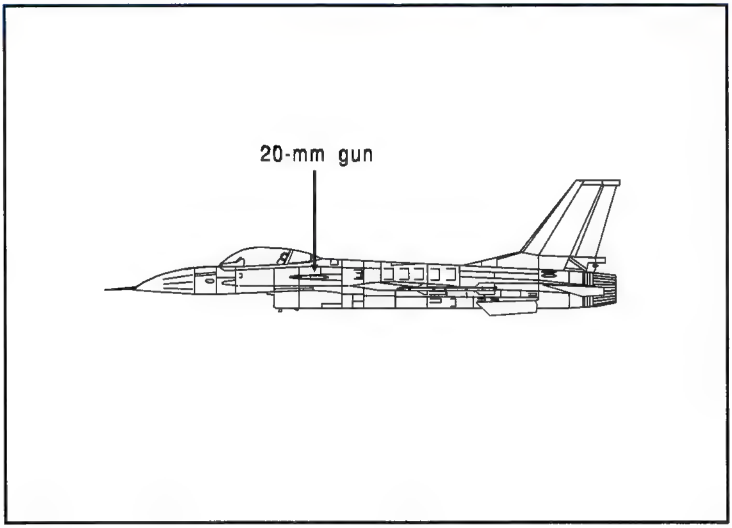
There are times in a fight when things get "up close and personal." This is dogfighting in the traditional sense; "traditional" because today, much of modern air-to-air combat is fought differently from the machine gun duels that have become associated with dogfighting from World Wars I and II. In most air-to-air combat engagements, the adversaries are thousands of feet or even miles apart, fighting with missiles. If no one gets morted quickly, these engagements usually get smaller and tighter until the opponents are virtually "fighting in a phone booth." When this occurs your missiles are useless. Missiles can be compared to the lance carried by a knight in a joust. You need a certain distance between the lancer and the lancee in order for this weapon to work. You definitely can't use it when you and your adversary are duking it out in a phone booth.

When you are hand fighting in close quarters, the best weapon is a knife. The F-16's air combat "knife" is the M61A1 Vulcan 20-mm cannon. The M61 is a six-barreled Gatling gun that fires 20-mm projectiles out to an effective range of 2,000 feet. The F-16 carries 510 rounds of 20-mm ammunition and fires at a rate of 100 rounds per second. When you are so close to the bandit that you can read his tail number, it's time to draw your M61. It is primarily an air-to-air weapon but can be used in the air-to-ground role in emergencies.

Lt. Paul Beck was the first man to release bombs from an airplane. On 19 January 1910 Beck dropped sandbags (as substitutes for the real thing) over the city of Los Angeles.

Figure 4-4.

The F-16 M61 20-mm gun



The F-16's M61 cannon, shown in Figure 4-4, is located on the left side of the fuselage above the left strake. The M61 in Falcon 3.0 is similar in many respects to the gun on the F-16. In Falcon 3.0, your F-16 carries 515 rounds and the gun is effective to a maximum distance of one mile. Figure 4-5 shows the gun in action.

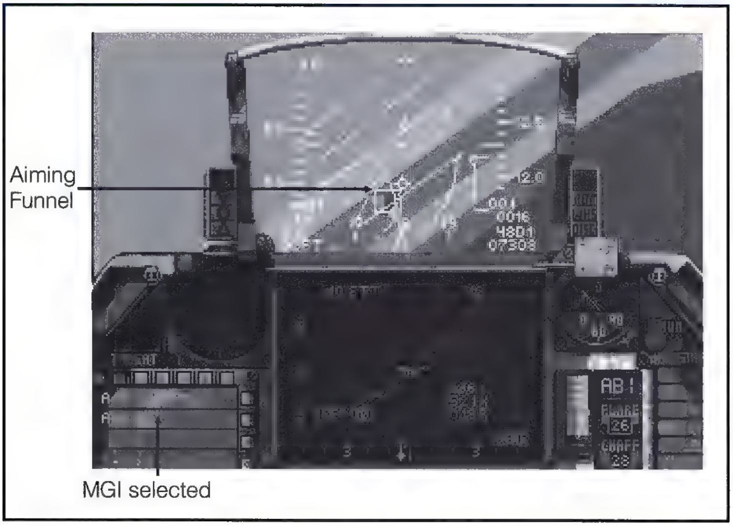
Falcon 3.0 Air-to-Air Missiles

The Sidewinder is a missile that was developed in the 1950s to augment the gun as an air-to-air weapon. During this period in air-to-air weapons development, attempts were made to shoot down air targets with unguided rockets. The rocket never developed into a dependable weapon but the natural evolution of this technology did lead to a "guided rocket" or missile.

The first versions of this missile were fielded in the late 1950s and gave the fighter pilot the ability to engage targets outside 2,000 feet, which was the range of the 20-mm gun. It

Figure 4-5.

Cockpit view of "Guns Kill" of a Mirage III Close quarters



was originally thought that AIM (Air Intercept Missile) targets would be bombers and the AIMs themselves would have a high degree of accuracy, hence the lack of A-A (air-to-air) cannon on early models of F-4s prior to Vietnam.

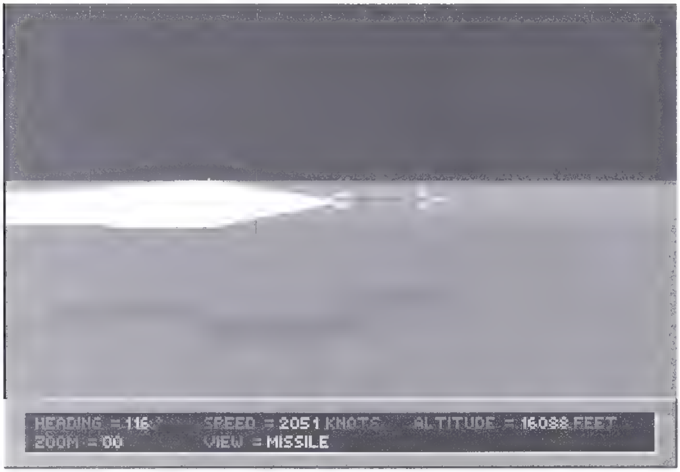
These air-to-air missiles use infrared energy (heat) from the engine of the target to guide the missile. Because it is an infrared-guided missile, the launching aircraft is free to maneuver after firing the missile, and does not have to maintain radar lock-on to guide the missile.

Many predicted that the first model Sidewinders would change the dynamics of air combat decades ago when they were first introduced. This prophecy went unfulfilled due to poor missile reliability and tight employment parameters of the early model Sidewinder missiles (which included the *J* model). These missiles were of limited use to the fighter pilot in maneuvering combat because they had to be fired within 30 degrees of the target's tail and could be easily outmaneuvered.

The Sidewinder was the world's first successful air-to-air missile.

Conversely, the AIM-9I did make a significant contribution to air combat. This missile could be fired from all aspects and performed very well against maneuvering targets. The AIM-9L or "Lima" had finally given the fighter pilot in a dogfight a dependable way to shoot a target outside of gun range.

The AIM-9M carried by the F-16 is a distant cousin to the early model Sidewinders such as the AIM-9J. It looks almost identical to those early missiles but the similarity ends with their appearance. The *M* or "Mike" version of the Sidewinder, shown in Figure 4-6, is a truly revolutionary air-to-air weapon because it is so much more accurate and effective than the *J* version. The AIM-9J was probably the first accurate air-to-air guided missile that could be used over long range. It marked the first time that a fighter pilot could accurately down planes in the air without a gun.



HEADING = 116 SPEED = 2051 KNOTS ALTITUDE = 16088 FEET
ZOOM = 00 VIEW = MISSILE

Figure 4-6.

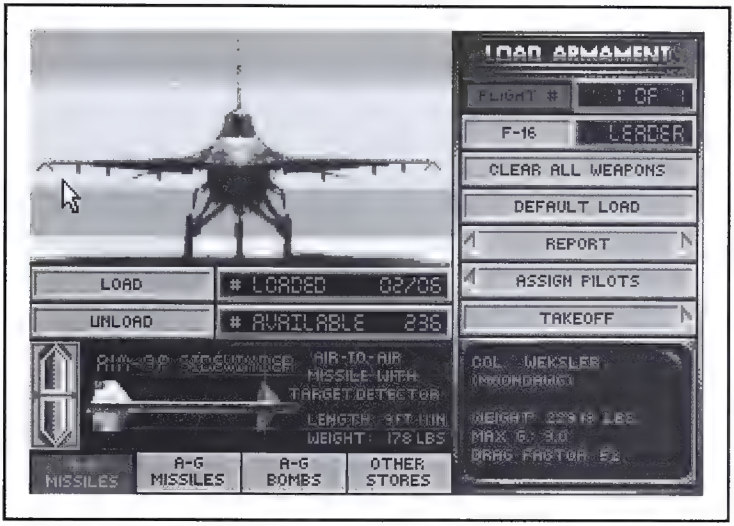
The AIM-9M Sidewinder in flight

Falcon 3.0 features two types of Sidewinder missiles: the AIM-9P or "Papa" (shown in Figure 4-7) and the AIM-9M (shown in Figure 4-8). The AIM-9P, like its AIM-9J predecessor in Falcon AT, is a rear-aspect heat-seeking missile; that is, it must be fired at the enemy target's rear quarter. The AIM-9P is the most common and least expensive air-to-air missile in Falcon 3.0, although it is not as accurate as its more sophisticated (and expensive) siblings. The effective range of the AIM-9P is six miles.

The AIM-9M Sidewinder, like its AIM-9L predecessor in Falcon AT, is an all-aspect heat-seeking missile; that is, it can be fired at the enemy target from any angle. You'll notice that the aiming reticle is larger than the AIM-9P's, which means it is easier to lock-on to an enemy plane. AIM-9Ms are more expensive than AIM-9Ps, which means they will be in shorter supply during a campaign.

Figure 4-7.

The AIM-9P Sidewinder



# LOADED 02/06

# AVAILABLE 236

AIM-9P SIDEWINDER AIR-TO-AIR MISSILE WITH TARGET DETECTOR

LENGTH:

WEIGHT: 178 LBS

COL WEKSLER

WEIGHT:

MAX G: 9.0

DRAG FACTOR:

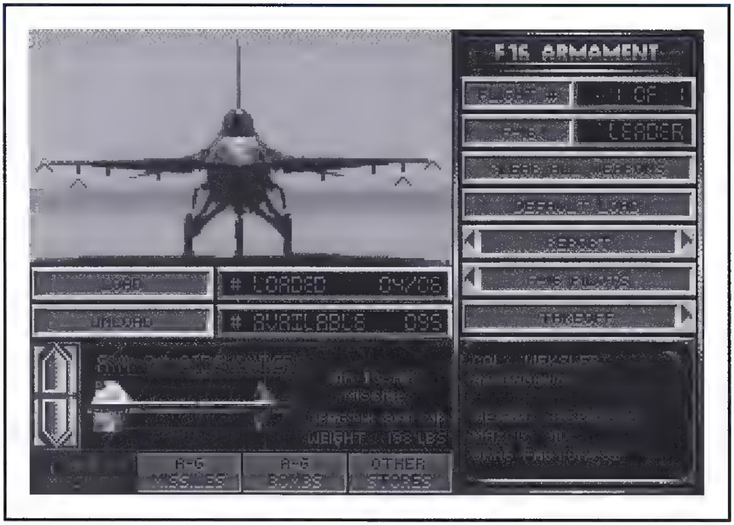


Figure 4-8.

The AIM-9M Sidewinder

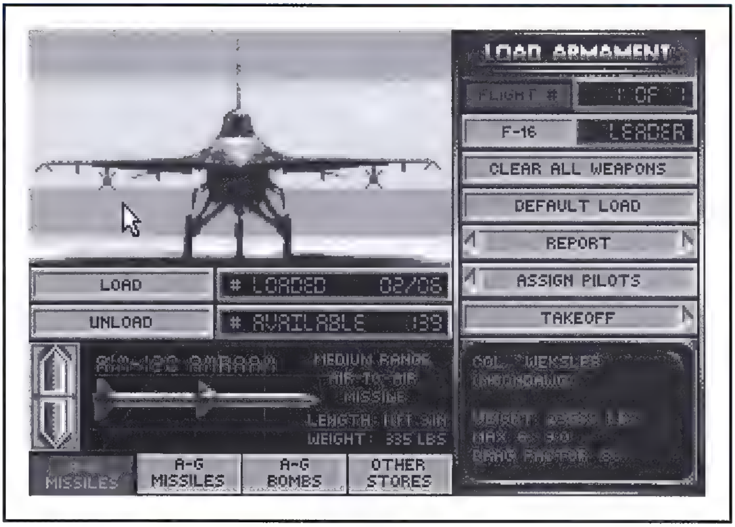
Falcon 3.0 also supports the newer AIM-120 AMRAAM (Advanced Medium Range Air-to-Air Missile), shown in Figure 4-9. This missile is quite sophisticated, and it is meant to be fired from a range of 30 miles—beyond visual range. It works in conjunction with a huge aiming reticle, but is ineffective at closer ranges. It is also quite expensive, so taxpayers don't want you shooting these off like bottle rockets in your backyard.

Lesson 6

Now before you go off half-cocked with a six-gun in each hand, you'll have to learn a bit more about your HUD and instrumentation. Let's get you up in the air and we'll see what we can see. In Lesson 6, you'll meet some bogeys—specifically, three Mirage IIIs and a MiG. But don't sweat it yet; these bogeys have been disarmed and don't have any fight in 'em. Don't get too cocky either, because in real combat, you can be sure that bogeys will use more than harsh language or their thrusters to get rid of you.

Figure 4-9.

The AIM-120 AMRAAM (Advanced Medium Range Air-to-Air Missile)



FLIGHT # 1 OF 1

F-16 LEADER

LOADED 02/06

AVAILABLE 139

WEIGHT : 335 LBS

Mission Profile

- Engage and destroy three Mirage IIIs and one MiG-23

Mission Objectives

- Proficiency in use of air-to-air ordinance, specifically, delivery of AIM-9P, AIM-9M
- Use AIM-120 AMRAAM and M1A61 cannon effectively against four bogeys

From the War Room, form your squadron by selecting the Form button underneath the squadron display. Next, select Red Flag—you'll then see the Red Flag Control screen. Use the up and down arrows in the upper-left corner of the video display.

Stop at the Armament Screen. Cycle through the options to see what's available to you. You'll notice that your F-16 has already been decked out with two AIM-9Ps, two AIM-9Ms, and two AIM-120 AMRAAMs. Knock yourself out, and pick up

***Remember:** You need a formed squadron to go to Red Flag.*

another two AIM-120s if you want, by clicking on the Load button after selecting the AIM-120 on the Armament Screen. Uncle Sam's buying.

Choose Lesson 6 and click on the Load Mission bar. You'll see the mission map appear on the screen. Click on the F-16 Pilots bar; you can choose any pilot from your squadron to fly this mission. Click on the F-16 Armament bar. You'll see the weapons systems available; you should be in the air-to-air missiles selection.

As soon as you've loaded up Lesson 6 and are in the cockpit, select your AIM-9Ps (the rear-aspect Sidewinders) by pressing ENTER or button 2 on your joystick; then press P to pause Falcon 3.0

Click on the Down Arrow bar until you see the AIM-120 AMRAAM. You should have two loaded. Click on the Load bar to load two more (four is the maximum you can carry). Don't worry about air-to-ground weapons or other stores for now; go ahead and click on the Takeoff bar. You should end up in the air at approximately 20,000 feet, 450 kph heading north.

Now, just when you're about to save our great nation, you're going to stop short. Press P to pause Falcon 3.0 again. It's time to learn about the HUD and its instruments before whipping into combat half-cocked. If you feel confident that you know the instruments, you can skip to the "Resuming Action" section later in the chapter. If you get shot down ten seconds after takeoff, then we'll meet you right back here.

HUD Combat Diplays

Take a good look at your HUD and its symbols, as shown in Figure 4-10. Each of the symbols will be described in the following sections.

The Target Designator Box

The TD (Target Designator) Box indicates where your current target is, if it is within your HUD. You may not be able to confirm a visual sighting of the bogey, but trust your radar. If your target is off your HUD, you'll see "XX" instead of a box. (See the "The Gun Cross"

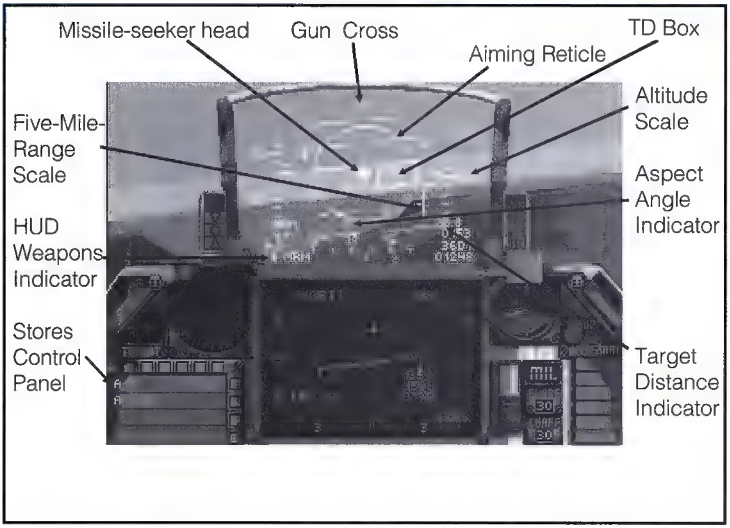


Figure 4-10.

HUD combat display

section, coming up shortly.) Keep your eyes on the HUD during a dogfight when a bogey is out in front.

The Aiming Reticle The Aiming Reticle is the large circle that functions as the targeting system for each of your three different A-A missile systems (AIM-9M, 9P, and AIM-120). When your target is within the reticle, your targeting system seeks to acquire a lock-on. When you achieve missile lock, your reticle flashes, and you hear a lock-on tone; hold your target with the reticle and let one fly.

Your AIM-9P has the smallest kill circle (or Aiming Recticle) at 35 milliradians (MR or mils), the AIM-9M has a 100 MR circle, and the AIM-120 AMRAAM has a huge 145 MR reticle.

***Note**: Keep in mind that each missile has a different size reticle. The larger the reticle, the easier it is to keep your target in your missile's sights and mort it.*

Remember:* *Follow the Target Locator Line right to your kill.

The Missile-Seeker Head A little diamond represents the seeker head of your selected missile. The AIM-9M's missile-seeker head will bounce around your HUD until it locks onto the target, whereupon it merges with the Target Designator Box. The other two missiles have their missile-seeker heads in the center of the HUD and Aiming Reticle.

The Gun Cross The Gun Cross is the small + at the top of your HUD. The Target Locator Line appears, extending away from the Gun Cross, when your target is out of the field of view of the HUD.

The HUD Weapons Indicator The HUD Weapons Indicator lets you quickly figure out which weapons you've selected. In it, you should see a number followed by the letters *SRM* (Short Range Missiles).

The number indicates how many missiles you have left, and the SRM indicates that you have chosen short-range missiles, which in Falcon 3.0 means the AIM-9Ms or the AIM-9Ps. If you have selected the AIM-120 AMRAAM, the letters will be *MRM*, or Medium Range Missile. Typically, these missiles will be armed (indicated by the letters *ARM* two lines above on your screen). If you wanna' get your hands dirty with a little old-fashioned dogfighting, you'll see *DGFT* when you select your M61A1 gun. You can also check your stores panel to see which weapon you've selected, but providing vital information without distracting you from your target is what the HUD is all about.

The Target Distance Indicator Located in the lower-right corner of the HUD, the Target Distance Indicator indicates the number of miles to your target. Like the Five-Mile-Range Scale, which appears to the left of the Altitude Scale, the Target Distance Indicator only functions when you are within five miles of your enemy. The caret in the Five-Mile-Range Scale tells your distance from the target; if the caret is at the top of the bar, you're about 5 miles away; if it's at the middle, you're about 2.5 miles away; if it's at the bottom of the bar, look sharp, because you're right on top of your target—or he's right on top of you.

The Aspect Angle Indicator The Aspect Angle Indicator shows you the *aspect angle*, which is the horizontal angle measured from the tail of the enemy aircraft to the nose of your F-16.

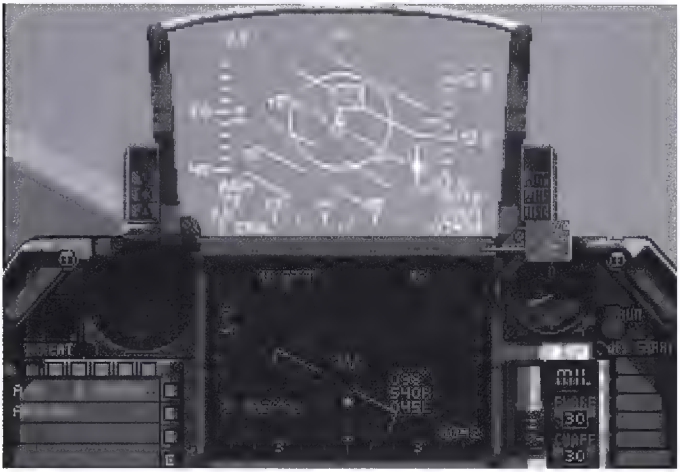
If you are on your bogey's six, the aspect angle should be 0 degrees. See Figure 4-11.

The concept of aspect angle can be hard to grasp if you're not seeing it from the canopy of an F-16. The angle is never more than 180 degrees, and the higher the angle, the closer the bogey is to pointing head-on (180 degrees). Aspect angle extends to either the left of your jet or to the right of it: think of it as connecting to whichever side of the canopy the enemy

Remember: *The smaller the aspect angle, the closer you are to tailing the bogey, and the better the chances for a clean kill.*

Figure 4-11.

WVR (Within Visual Range) target acquisition. Note low target aspect angle



pilot has to look out to see your aircraft. An enemy aircraft with 35 degrees of left aspect is pointing away from you at 35 degrees (angle measured from line drawn from your nose to the enemy's tail), and the enemy has his left side to you–that is, he has to look out of his left window to get a look at you. Think of the aspect angle caret on your missile reticle as the tail of your enemy's aircraft as seen from above, with the opposite side of the reticle being his nose.

The Radar/Electro-Optical Display (REO)

Your Radar/Electro-Optical display, or REO, is the screen immediately below your HUD with the "W" shape between two horizontal lines (if your F-16 is in a horizontal position). As you roll your F-16, you'll notice that the horizontal lines duplicate your roll.

A green square is another plane. Depending on what radar mode you have selected in your Config screen, you may see shadow blips. The REO helps determine whether or not you are going to engage your target in a transverse intercept or a head-on intercept. (More on this in Chapter 5, which covers the specific radar modes available in Falcon 3.0.)

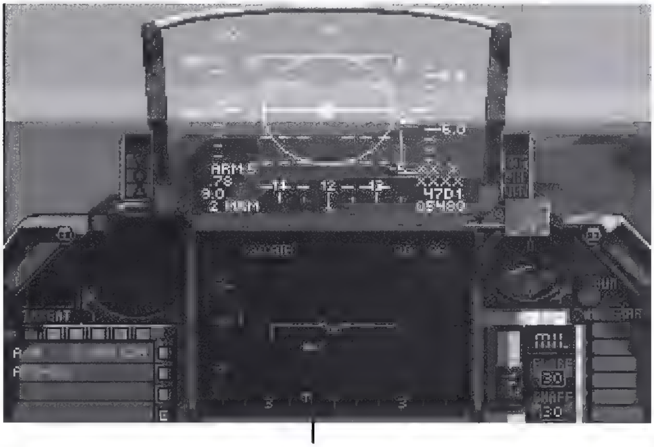
To cycle targets on your radar screen, press T. Each radar-locked target (remember this is *not* missile lock) appears as a diamond blip on your REO, and other targets appear as square blips. Figure 4-12 shows APG-66 radar in NAM (Normal Air Mode). You'll learn more about NAM in Chapter 5.

The readout in the top-left corner of your REO should show something like "20 SAM." SAM stands for Situational Awareness Mode, which simply means that the radar will automatically change its scanning range depending on the position of the bogey. "20" means it's in the 20-mile scanning range mode. SAM radar assumes that you are at the bottom of the radar (as viewed from a top-down perspective); a bogey at the very top would be 20 miles away. As the bogey comes within a 10-mile range, the radar will switch to "10 SAM" or "10 STT."

STT stands for Single Target Track, meaning your radar is tracking a single target, as shown in Figure 4-13. Once you

Figure 4-12.

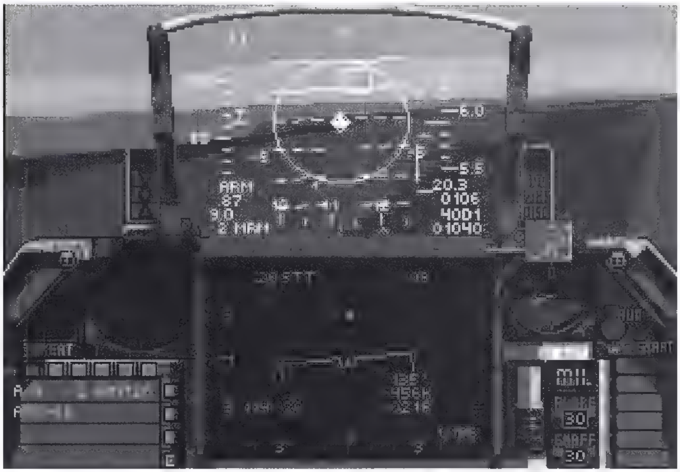
The APG-66 radar in NAM (Normal Air Mode)



Target blip

Figure 4-13.

The APG-66 radar in STT (Single Target Track) mode



toggle your radar to STT mode, your REO screen will begin to provide you with some vital information regarding your target, such as the speed, heading, and position of the bandit relative to you.

Actually, your enemy will receive your active radar signal with a passive receiver (like your TWI or Threat Warning Indicator) before you get a return on him in your screen. Therefore, it is wise not to leave your radar on as this gives your opponent more than enough warning to figure out where you are and what you may do.

The Enemy Altitude Indicator The number in the top-right corner of the REO is your enemy's altitude in thousands of feet (0 is sea level).

Note: *Your enemies turn their radar on and off too. That's why you don't see a sustained "spike" in your TWI sometimes. Just a quick on and off.*

Enemy Heading, Airspeed, and Aspect Angle Indicators

The enemy heading, airspeed, and aspect angle are provided in the lower-right quadrant of your REO. The top number is a number in degrees, which shows your target's current heading. The number right below that, which should read something like "456K," shows your target's airspeed in kph. Finally, the number below that is the enemy's aspect angle, explained earlier in this chapter. Try to keep this number close to 0. You can be sure the bogey will do his best to keep you off his six and keep his aspect angle at 180°.

You can determine what your enemy is up to with just these few readouts, especially when he is BVR (Beyond Visual Range, explained shortly). For example, watch for a sudden reduction in speed and a corresponding swing in aspect angle. This tips you off that the bogey is starting to turn.

Note: *The faster the change in aspect, the more Gs pulled in the turn.*

Once you have determined that your enemy is turning on you, watch your *smash* (overtake airspeed). If engaged in a WVR (Within Visual Range, as opposed to a BVR or Beyond Visual Range) dogfight, too much overtake airspeed means you will overshoot your enemy. If you've seen *Top Gun*, that MiG that Tom Cruise pulled the old airbrake trick on had some excess smash.

The Enemy Bearing and Distance Indicator In the lower-left corner of the REO you'll see a number like "359° 06". This is the Enemy Bearing and Distance Indicator. The first part of that readout shows the compass direction from your F-16 to the enemy. 359° means he is almost directly ahead. The number following (06 in the example here) is the bogey's distance in miles from your F-16.

The Closure Rate Indicator The number in the extreme lower-right corner of the REO gives the closure rate in kph. A positive number means you are closing at the indicated speed; a negative number means your target is pulling away from you. Overtake airspeed is referred to as smash.

The Threat Warning System Finally, here is the instrument that every pilot hates to hear from but that has saved a lot of pilots' lives: the Threat Warning System.

This instrument, located above your Stores Panel and to the left of your REO, consists of a circle and panel.

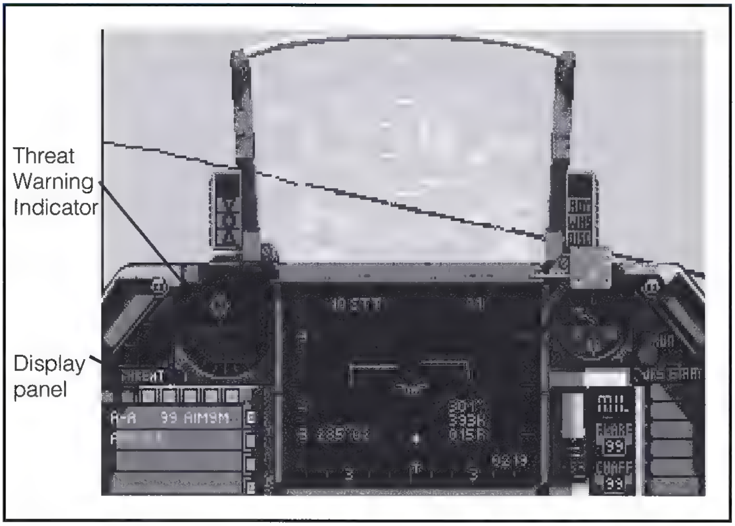
The panel has two displays. The first is "LCK", which means an enemy target (and it could be a plane or ground installation) has locked on to your bird. You may want to take evasive maneuvers or use ECM (electronic countermeasures) or a chaff pod to save your butt. (Evasive measures are covered in Chapter 5.) The LNH light means that a missile has been launched. If this light goes on, you had better take some action to defend yourself.

The circle is the Threat Warning Indicator (see Figure 4-14). Notice that the circle is divided into quarters. Imagine your wingspan forms the horizontal diameter line of the circle. The top half of the circle is the forward viewing half of your F-16 (from your wingspan up), while the lower half represents the lower half of your airplane. Within the Threat Warning Indicator you may see three different types of threat indicators. A diamond means an enemy plane is within 30 miles of your F-16. The number in the diamond corresponds to the radar band the plane is emitting, from which your computer

The icons in the RWR (Radar Warning Receiver, another name for the Threat Warning Indicator) are referred to as "spikes," from the days when they really used to look like spikes.

Figure 4-14.

The Threat Warning System



can guess the configuration of the enemy aircraft. A large green square means a radar installation is tracking you. A number 1 means the radar is continuous wave; 2 means it's pulse-Doppler radar. This might make you wish you were in one of those F-117s, even though they handle like recreational vehicles, because radar wouldn't be able to track you (remember, the F-117s are stealth fighters).

Finally, a small green square means a radar-guided SAM has been launched within 30 miles of your F-16—right at you.

Back in the Cockpit

Do the HUD instruments sound like a lot to handle? Well, they are. No one ever said staying alive in combat was easy, especially with today's level of technology. But for now, relax and take advantage of your first easy kills.

Look at your cockpit again; it should look like Figure 4-10, which shows the missile HUD and Stores Control Panel, or SCP displays. Both Sidewinder models (the AIM-9M and AIM-9P) as well as the AIM-120 AMRAAM have nearly identical HUD displays in Falcon. The SCP shows which missile you have selected. You can change between missile types with the ENTER key or button 2 on your joystick. Remember that pressing the ENTER key moves you through the Air-to-Air Weapons menu, which includes the AIM-9M, AIM-9P, AIM-120 and the gun mode. When in the air-to-air missile mode, the letters *SRM* are displayed in the lower-left corner of the HUD. On the same side of the HUD underneath the Airspeed Scale is the word *ARM*.

To summarize, the most prominent missile HUD display is a large Aiming Reticle in the center of the HUD. This reticle gives you an aiming reference for shooting the missile. Another missile reference is a diamond that appears inside the Target Designator (TD) Box. (If you have selected the all-aspect AIM-9M, the diamond will bounce around your HUD until it locks onto a target.) The TD Box gives you an aid in the HUD for finding targets. This box appears in the HUD when the radar is locked on to a target and the target is in the field of view of the HUD.

The reticle will flash, the target diamond will merge with the TD box, and you will hear a lock tone when the following conditions are met:

- The radar is locked on to a target.
- The target is in the field of view of the HUD.
- The AIM-9 missile has locked on to the target.

Resuming Action

Make sure you have your AIM-9P selected by checking your SCP. Press P to get out of the Pause mode.

You should be tracking a retreating Mirage III, as shown in Figure 4-15. Now in combat, you'll want to press N to check if your targeted plane is a friendly. If it is, pressing N will give you a loud squawk and the IFF light will illuminate. This helps

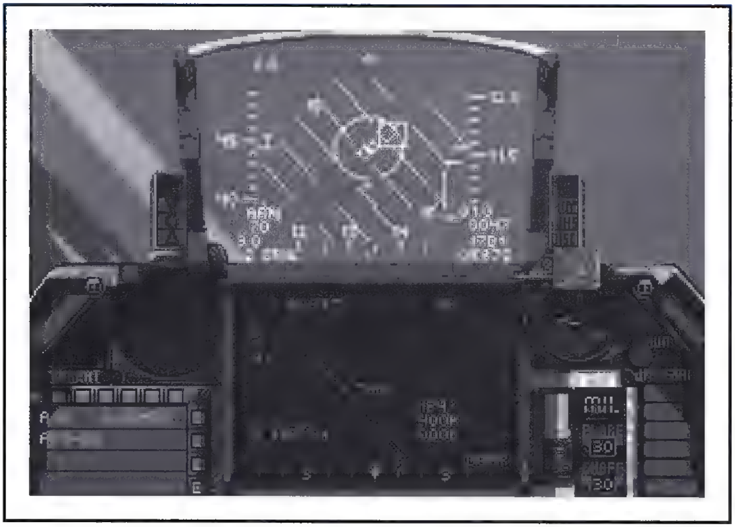


Figure 4-15.

AIM-9P locked on a Mirage III, within firing parameters

keep you from shooting down your buddies. (Targeting and tracking will be discussed later in this chapter.)

Meanwhile, keep the Mirage III's TD Box in your reticle and wait for the Sidewinder's distinctive growling noise to turn into a high-pitched whine. The whine means your AIM-9P has locked on. Your reticle will flash, and you can fire by pressing button 1 on your joystick or pressing the SPACEBAR on your keyboard. Watch your missile seek out and hopefully destroy your target.

For real viewing satisfaction, press Q to check out the enemy plane or missile views while this is happening. Remember, this Mirage was running away, and your AIM-9P locked onto the rear aspect of the fleeing fighter. Congrats, you've just smoked your first bogey. Bring your F-16 around to heading 0 degrees and press button 2 on your joystick, or the

ENTER key on the keyboard, until you've brought up one of those pricier but more effective AIM-9Ms. Another Mirage III will appear on your scope.

Keep the Mirage III in your reticle and wait for the bouncing missile seeker head to merge with the TD Box. (If there is more than one target in the air, you can change targets by pressing T.) The reticle will flash, indicating missile lock. You may want to see your F-16 launch this missile, so fire and press 7 to check out an outside view. Switch back to your cockpit view by pressing 3 and watch the missile take out the Mirage. Now bring up your AIM-120 in your SCP and continue heading north (0 degrees). You should see another TD Box. Keep this Mirage centered in your reticle. When you see the TD Box appear, your reticle should flash soon after. Fire your AMRAAM at this target and notice how far away it is. You've just sent a bogey a long-distance calling card, courtesy of the USAF. When you've eliminated this Mirage, switch over to your M61A1 gun and press P to pause the game again.

***Remember:** The AIM-9M may be your primary air-to-air weapon in Falcon 3.0. The AIM-9M is extremely deadly and affords you great tactical flexibility when fighting bandits, especially when coupled with the longer range AIM-120 AMRAAMs. The AIM-9P has more restrictive parameters but is less expensive and so more plentiful during a campaign, and still allows you to engage hostiles several miles out.*

The HUD Gun Displays

Employing the gun against bandits requires knowledge of Falcon 3.0 HUD symbology associated with gun aiming. Aiming the gun at a target moving in three-dimensional space involves some non-trivial physics calculations. The problem of aiming the gun is one of predicting the future event of bullet-target intersection. The F-16 (and Falcon 3.0) solve this problem with the *Aiming Funnel.* This aiming device predicts target movement and gives you an aiming reference to shoot the gun at the target. This aiming reference is valid if the shooter (that's you) and the target flight parameters remain constant for the time it takes the bullet to get from the shooter to the target. For most gun shots this is less than one second.

Figure 4-4 shows the gun display in the Falcon HUD and the SCP. You enter the gun mode by pressing the ENTER key on the keyboard until "M61" appears on the SCP. Depending on the weapons load you've specified in your preflight armament load, the SCP display will change between "AIM9M," "AIM9P," "AIM120," and "M61," each time you press the

***Note:** The farther you are from the target, the bigger the errors in the Aiming Funnel system because bullet time of flight, from shooter to target, increases.*

ENTER key. These displays inform you that you are in the air-to-air gun mode and the trigger (the SPACEBAR) will shoot the gun, if pressed. The HUD display in Figure 4-5 shows the Gun Cross and the Aiming Funnel. The Gun Cross is used in the F-16 to show you the departure line of the bullets. It also gives you a reference in the HUD for the nose position of the aircraft.

The *Aiming Funnel* is the spaghetti-like line depicted in Figure 4-5 that thrashes around the HUD when you maneuver. It tells you where the bullets would have gone if you had been firing.

***Remember**: The Aiming Funnel is useful in making gun shots because the bullets end up at the narrow part of the funnel, so try to keep the narrow end of the funnel on your target. Notice how the funnel elongates as more Gs are pulled.*

Gunning MiGs

An old fighter pilot adage is "MiGs were born to die." The 20-mm gun can certainly help make these words ring true. Press P to resume the fight. In order to kill a MiG in the simulation you must get in range and place the narrow part of the Aiming Funnel over the MiG. Once these two conditions are met, you are ready to fire. Chapter 6 explains the finer techniques of killing bandits in a dogfight.

There should be a MiG coming at you; practice on it to see what it takes to score gun hits on a fighter. Deflection shooting (leading your target out) isn't so easy when your target is a supersonic fighter, is it?

***Remember**: Your gun is only effective to about one mile. Keep your target inside the narrowest part of the Aiming Funnel before you let loose.*

Well, those are the basics for air-to-air combat. Press ESC, and choose the End Mission option, which will target you back to Nellis. The next section shows you the Air-to-Ground Weapons Delivery system that proved so effective in the Iraqi conflict.

Falcon Air-to-Ground Weapons Delivery Systems

There are two categories of air-to-ground weapons in Falcon 3.0: free-fall (dumb bombs) and guided munitions (missiles or guided bombs). This section gives a brief synopsis of what your F-16 can unload on ground targets.

Dumb Bombs

It might seem that, apart from size, all bombs are alike. This isn't true. Specific free-falling bombs were designed to most effectively take out certain types of targets. It's important to pick the right munitions for the job at hand.

The Mark 82 Iron Bomb Mk-82s are generally used against softer targets, such as infantry and light armor. They can also be used against small buildings, although you should use more than one against structures since one may not be enough to flatten them. Mk-82s are pretty cheap and therefore plentiful; what's more, your F-16 can hold 24 Mk-82s. Expect to make good use of these bombs, shown in Figure 4-16, to soften up targets.

The Mark 82HD Snake Eye Bomb The Mk-82HD Snake Eye bomb is similar in firepower to a Mk-82, but has fins that slow the bomb down in free-fall. This allows you to release the bomb at a lower altitude and still have enough time to clear the blast radius. The Mk-82HD Snake Eye bomb is shown in Figure 4-17.

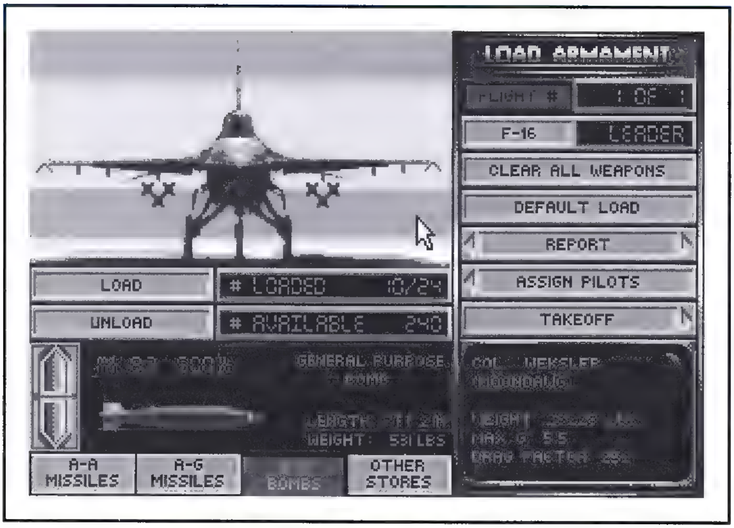
The Mark 83 Iron Bomb The Mk-83, shown in Figure 4-18, is used against medium-size targets such as railroad shelters, average buildings, and oil tanks. It weighs about twice as much as the Mk-82.

The Mark 84 Iron Bomb The Mk-84, shown in Figure 4-19, is the largest and heaviest of the iron bombs, so you can use it against the largest structures such as bridges, aircraft hangars, bunkers, you name it. Each Mk-84 weighs about a ton, twice as much as the Mk-83, but it's guaranteed to wake up those guys on the ground—in the next time zone.

The CBU-84 Cluster Bomb One CBU-84 cluster bomb contains more than 200 little bomblets. This is especially effective against softer targets such as light armor and infantry, since

Figure 4-16.

The Mk-82 500lb bomb



LOADED 10/24

AVAILABLE 240

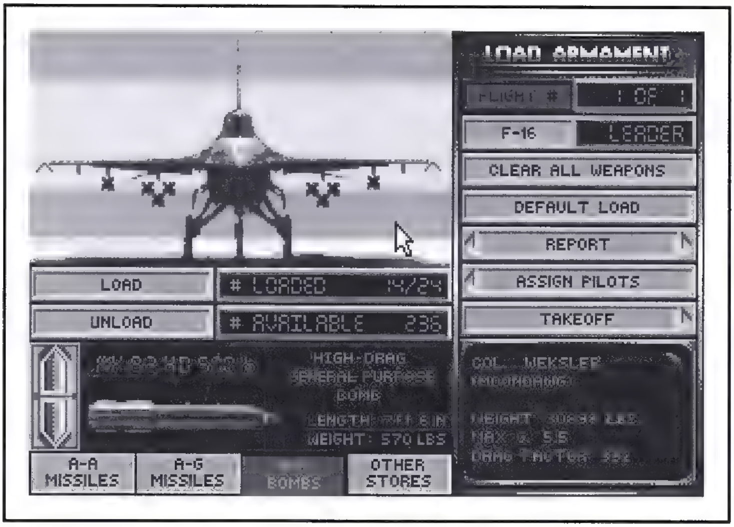
GENERAL PURPOSE

WEIGHT: 531 LBS

MAX G: 5.5

Figure 4-17.

The Mk-82HD Snake Eye 500lb retarded fall bomb



LOADED 14/24

AVAILABLE 236

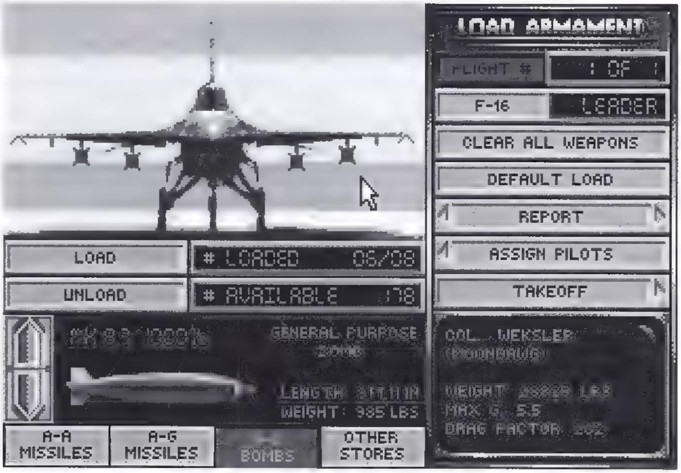
HIGH-DRAG GENERAL PURPOSE BOMB

WEIGHT: 570 LBS

MAX G: 5.5

Figure 4-18.

The Mk-83 1000lb bomb



LOADED 06/08

AVAILABLE 178

GENERAL PURPOSE

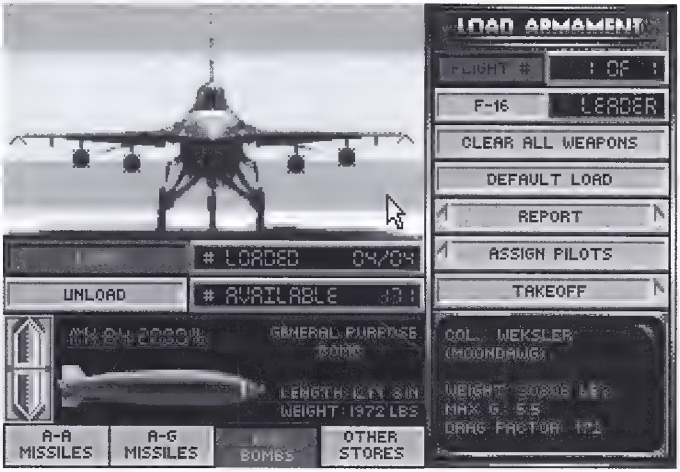
WEIGHT: 985 LBS

COL. WEKSLER

MAX G: 5.5

Figure 4-19.

The MK-84 2000lb bomb



LOADED 04/04

AVAILABLE

GENERAL PURPOSE

WEIGHT: 1972 LBS

COL. WEKSLER
(MOONDAWG)

MAX G: 5.5

the little bombs will disperse and score a lot of hits. See Figure 4-20 to see what a CBU-84 cluster bomb unit looks like.

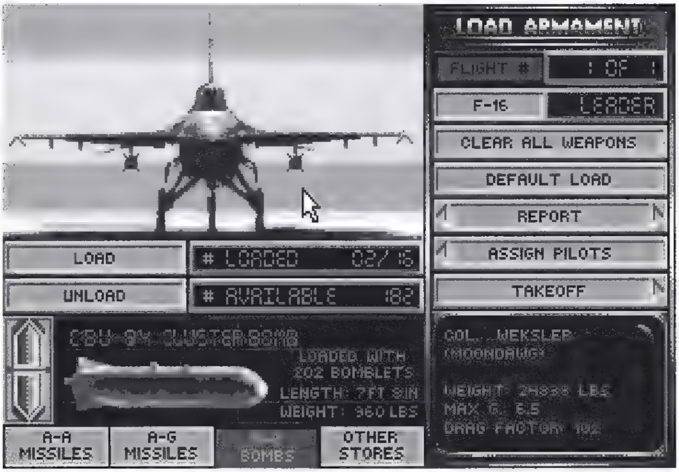
Smart Bombs

While the guided weapons covered in this next section can be much more effective in taking out strategic targets than dumb bombs are, smart bombs are also much more expensive than dumb bombs. In these days of budget cuts, armed forces must weigh the benefits of effectiveness versus expense, and carry a combination of smart and dumb bombs.

The GBU-15 Laser-Guided Bomb The GBU-15 laser-guided bomb, shown in Figure 4-21, carries the firepower of a Mk-84 and also carries an electro-optical or television-imaging tracking system. When this munition locks on to a target, it uses control fins to glide after its goal. This weapon is quite expensive (and heavy, at 2510lbs), so you'll want to save this

Figure 4-20.

The CBU-84 Cluster Bomb Unit



FLIGHT # 1 OF 1

F-16 LEADER

LOADED 02/ 16

AVAILABLE 182

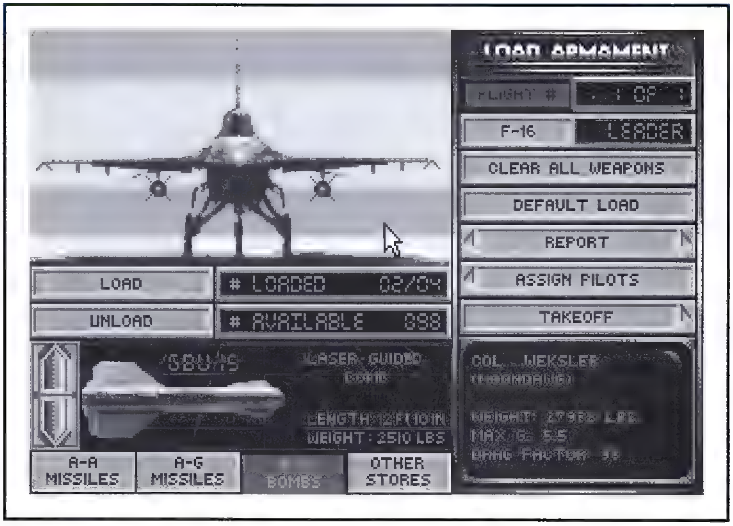
CBU-84 CLUSTER BOMB
LOADED WITH
202 BOMBLETS
LENGTH: 7FT 8IN
WEIGHT: 960 LBS

COL. WEKSLER
(MOONDAWG)

WEIGHT: 24838 LBS
MAX G: 6.5
DRAG FACTOR: 102

Figure 4-21.

The GBU-15 Guided Bomb Unit



LOAD ARMAMENT

FLIGHT # 1 OF 1

F-16 LEADER

LOADED 02/04

AVAILABLE 888

GBU-15

LASER-GUIDED

WEIGHT : 2510 LBS

COL. WEKSLEF

MAX G: 5.5

bomb for very important strategic targets such as command bunkers or nuclear weapons facilities—any large target whose removal you have to ensure.

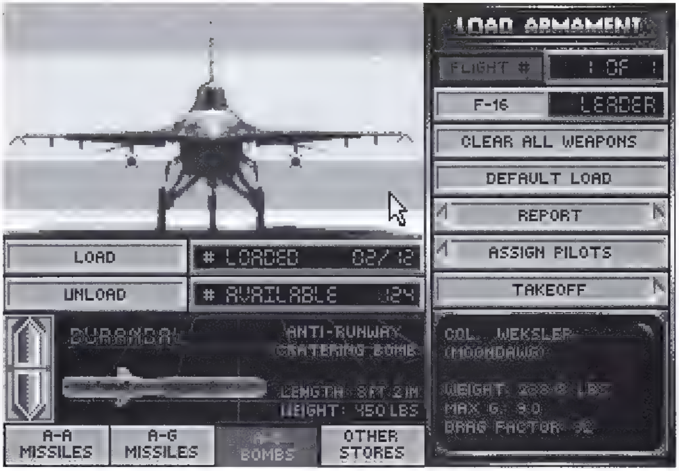
The GBU-15 is targeted much like the Mavericks. When you select the GBU-15, an Aiming Cross will appear in the middle of your HUD. Line up the Aiming Cross with your target. An image of the target will appear in the REO when your GBU-15 locks on. You can release the GBU-15 from a maximum of five miles out, depending on the angle of approach toward the target. For best results, wait until you are fairly close to the target—as close as you would be to drop a dumb bomb.

The BLU-108/N Durandal The BLU-108/N Durandal, shown in Figure 4-22, is only used against runways. It buries itself on impact and explodes, making life hell for the roads

A B-29 Superfortress named Enola Gay, *captained by Col. Paul W. Tibbets, Jr., carried the world's first atomic bomb to its destination of Hiroshima, Japan.*

Figure 4-22.

The BLU-108/N Durandal



FLIGHT # 1 OF 1
F-16 LEADER
# LOADED 02/12
# AVAILABLE 124
DURANDAL
ANTI-RUNWAY CRATERING BOMB
LENGTH: 8FT 2IN
WEIGHT: 450 LBS
COL. WEKSLER (MOONDAWG)
WEIGHT: [illegible] LBS
MAX G: 9.0
DRAG FACTOR: [illegible]

department. As was learned in the Iraqi conflict, however, it really isn't that difficult to patch up a runway. Even so, one of these babies will make takeoff just a little bumpier for enemy aircraft.

Several things need to happen for a Durandal to work. First, it is dropped like a normal bomb; after release, a parachute stabilizes it in a vertical position. Next, a radar fuse senses the ground and at the proper height ignites a rocket motor in the tail end of the bomb, which burrows the bomb into the runway. Finally, the fuse detonates, and the bomb explodes, creating a deep hole in the concrete. At this point the enemy's runway repair unit, which normally consists of several grunts with shovels, quickly converges on the aforementioned hole to fill it in. All in all, it is not a bad weapon for performing the very difficult task of destroying concrete. The Durandal is the best weapon currently available to attack runways, which are very hard to destroy and easy to fix.

***Note**: Dumb or free-fall bombs are unguided; the airplane must use on-board aiming systems to drop them with precision. When a bomb is released, it falls to earth on a ballistic trajectory (meaning like a brick) and does not correct itself in flight. A smart bomb (such as the GBU-15 laser-guided bomb) makes small corrections in flight as it homes in on reflected laser energy. Missiles such as the Maverick are self-guided and propel themselves into the target after lock-on and launch.*

Falcon 3.0 Air-to-Ground Missiles

There are four types of air-to-ground missiles you can load onto your F-16 in Falcon 3.0: the AGM-65B Maverick, the AGM-65D Maverick, the AGM-45A Shrike, and the AGM-88A HARM. Each missile has different performance parameters, which you'll be debriefed on now.

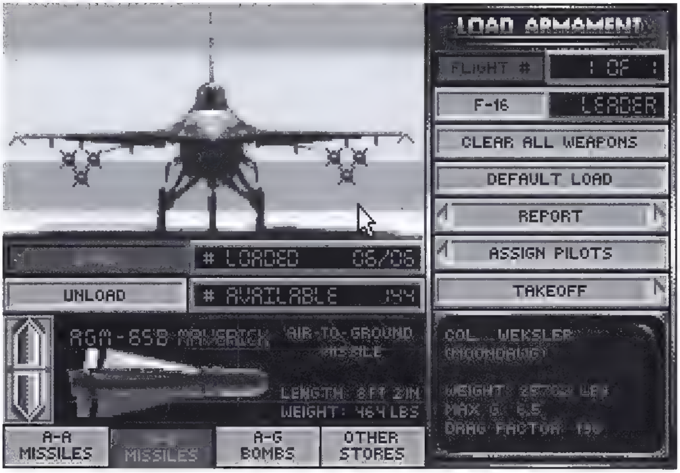
The AGM-65 Maverick The AGM-65 Maverick is a launch-and-leave weapon that is locked on to a target manually by the pilot. After lock-on and launch, the missile steers to the target using its own on-board guidance system. Because of this launch-and-leave feature, you do not need to track the target after the missile is fired. The Maverick is a good weapon against tanks and other moving targets due to its ability to self-track the target after launch. It can also be used on all other targets in the Falcon 3.0 world (except runways). The Maverick missile has a maximum range of 12 miles in Falcon 3.0.

The AGM-65B and the AGM-65D are the two types of Mavericks available to you. The AGM-65B, shown in Figure 4-23, is an electro-optical (EO) version of the Maverick. This missile tracks by a TV sensor in its nose, so it's generally used in the daytime with good weather conditions. It also can be used at targets against a large heat source (such as the huge expanse of desert sands in Iraq), which might fool an infrared or heat-seeking missile.

The AGM-65D is an infrared version of a Maverick. These are best used during the night or poor weather conditions, when the ground does not reflect as much heat from the sun.

Your F-16 can carry two other types of missiles: the AGM-45A Shrike and the AGM-88A HARM. These anti-radiation missiles are used against mobile or fixed radar installations.

The AGM-45A Shrike Missile The AGM-45A Shrike missile is an anti-radiation missile used against continuous wave (CW) radar. (You can determine what kind of radar is painting you from your Threat Warning System.) The Shrike's maximum



FLIGHT # 1 OF 1

F-16 LEADER

LOADED 06/06

AVAILABLE

AGM-65B MAVERICK AIR-TO-GROUND MISSILE

LENGTH: 8 FT 2 IN

WEIGHT: 464 LBS

COL. WEKSLER

MAX G 6.5

Figure 4-23.

The AGM-65B Maverick

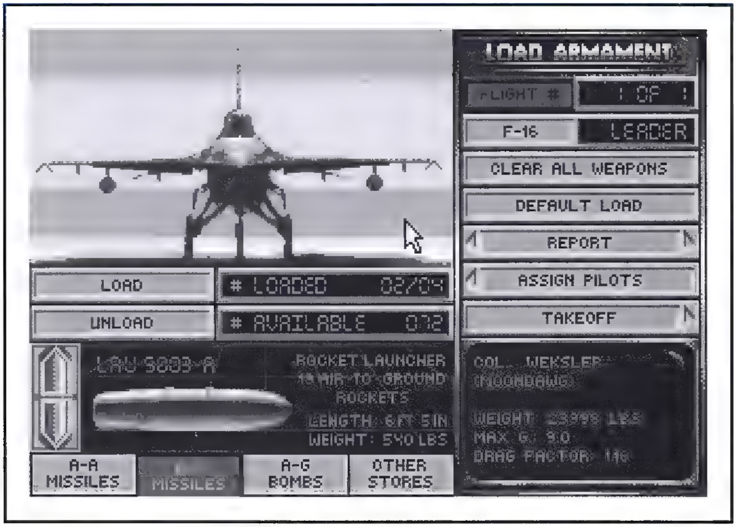
range is about 12 miles. CW radar is the most common defensive radar system, although it is not used in the SA-8 SAM system. Happily, Shrike missiles are relatively cheap and should be in good supply during a campaign.

The AGM-88A HARM Missile The AGM-88A HARM missile system is effective against CW and pulse-Doppler radar systems. It has an impressive range of 30 miles, but as you may have guessed, is quite expensive.

The LAU 5003A Rocket Launcher Finally, your F-16 also can carry a LAU 5003A rocket launcher, shown in Figure 4-24. Each LAU pod holds 19 small air-to-ground missiles. These missiles are not guided, but are launched much like bombs—you just point and fire. These rocket launchers are quite effective against softer targets such as infantry and light armor.

Figure 4-24.

The LAU 5003A rocket launcher



LOADED 02/04
AVAILABLE 032

LAU 5003-A
ROCKET LAUNCHER
19 AIR TO GROUND ROCKETS
LENGTH: 6FT 5IN
WEIGHT: 540 LBS

COL. WEKSLER
(MOONDAWG)

WEIGHT: [illegible] LBS
MAX G: 9.0
DRAG FACTOR: [illegible]

Now that you know what your fangs can do, let's use 'em. Load up Lesson 7A, and you'll start with the air-to-ground missiles. Once you have the F-16 Armament screen, select the Other Stores bar and load the ECM (Electronic Countermeasures) pod.

Lesson 7A

You'll be shooting at Nellis' ground target range, which will give you nice, tame targets that don't shoot back. Let's get reaquainted with your HUD. Press P to pause Falcon 3.0.

Mission Profile

* Locate and destroy ground armor force

Mission Objective

* Learn targeting and delivery of Maverick missile against ground armor forces

Maverick HUD Symbology

The primary aiming reference you use for Maverick missile lock-on is the Aiming Cross. You enter the Maverick mode by pressing the BACKSPACE key until "AGM65" appears in the SCP and the letters *E* through *O* appear in the lower-left corner of the HUD. You will see *ARM* in the lower-left quadrant of your HUD as well, indicating that your Maverick is armed. Line up the Aiming Cross with the target; you will get missile lock-on when the target's image appears in your REO. See Figure 4-12 for an example of a Maverick missile lock. In addition, a Target Designator Box will appear around the target and a range readout in feet, from your jet to the target, will appear in the lower-right corner of the HUD.

You launch the missile after lock-on by pressing SPACEBAR or button 1 on your joystick. The missile will fire and guide (steer) toward the target. You can cancel lock on a target (and then lock onto another target) by pressing the X key to reject the lock. This returns the Maverick to the "before lock-on" mode.

You can also press X to clear your lock and acquire a different target before the first missile reaches the target. After firing the first missile, press the X key and steer the Aiming Cross over the next target, lock-on, and shoot. You can follow the same procedure for the AGM-65D, the IR (infrared tracking) Maverick.

Press Q to follow the missile by engaging the missile camera. You will transform your entire screen to a view looking out from the Maverick missile itself. You can stay in this mode and "ride" the missile to the target while using the same camera rotate view keys (F1, F2, F3 and F4, and the SHIFT-combinations) described in Chapter 3, or you can exit this mode by pressing 3. This feature of viewing the target from the perspective of the missile is the best way to ensure elimination of your target.

The AGM-65 Mavericks have a number of control keys that can be used by the pilot. The following sections review these keys.

Remember: *The Mavericks are "fire-and-forget" missiles, which means you don't have to guide them (or pay attention to them) after launch; don't lock onto the shrubbery next to the mobile SAM launcher and you should be OK.*

The BACKSPACE Key Use BACKSPACE to enter the air-to-ground weapons mode and move through the different weapons selections.

The SPACEBAR Key Pressing the SPACEBAR fires a missile. Joystick button 1 does the same thing.

The X Key Pressing X breaks missile lock-on and return to "before lock-on" HUD symbology.

The Q Key Pressing Q shows the view from the missile-seeker head while the missile is in flight.

The 3 Key Pressing 3 returns the screen to normal from the Missile View mode.

Press P to get out of Pause mode, and make sure that you've selected the AGM-65Bs–if you haven't, press BACKSPACE until you see the AGM-65B in your SCP. Check your altitude. You should be flying at around 3,000 feet, heading north. Nose your F-16 down and look for the little specks on the ground. That's the official Nellis tank park, and those specks will be your targets for today. Aim your Aiming Cross at one of the tanks; when the image appears in the REO, fry the hulk by pressing your SPACEBAR. Press T to lock-on to something else. Go ahead, knock yourself out.

OK, that's enough flying. Press ESC and select End Mission to return to Nellis. Load up Lesson 7B and head right to the cockpit; your F-16 comes with a number of Mk-82s. Press P to pause while you review the HUD modes associated with bombing runs.

Lesson 7B

Mission Profile

* Engage ground armor forces with non-guided munitions

Mission Objectives

* Use dumb (Mk-82s) munitions against a ground armor force

- Become familiar with free-fall weapons delivery system
- Use M1A61 cannon in strafe maneuver

Falcon 3.0 Bomb HUD Symbology

You drop bombs in Falcon using the *Continuously Computed Impact Point* (CCIP) mode. CCIP is a computed delivery mode that takes into account the ballistic characteristics of the bomb and the motion of the aircraft. Using this information, an on-board computer determines the impact point on the ground that the bomb will hit and presents you with this "bomb solution." The bomb solution is seen in the HUD as an aiming cue or *Pipper* (also known as the Death Dot), which is displayed as a circle with a dot in it. You then fly the Pipper over the target and drop the bomb. Specific techniques on dropping bombs will be covered in Chapter 6. For now, just focus on learning the air-to-ground HUD symbology shown in Figure 4-25.

CCIP Symbology

When you call up the bombs on your SCP you will automatically enter the CCIP mode. You call these bombs up in the SCP by pressing the BACKSPACE key. The BACKSPACE key takes you out of the air-to-air weapons mode and moves you through the air-to-ground weapons rotary. Once you have selected your bomb, the letters *CCIP* will appear in the left corner of the HUD. The most important display in the CCIP mode is the Pipper, labeled in Figure 4-25. It is attached to the Bomb Fall Line, or the Displayed Impact Line shown above it. This line connects the Flight Path Marker to the Pipper and shows the future path over the ground that the Pipper will take as the aircraft moves through the sky. Why this is important will be explained when bombing techniques are described in Chapter 6. The Flight Path Marker, the Bomb Fall Line, and the Pipper are the primary displays you use to drop bombs in Falcon 3.0.

There is an additional display in the CCIP mode that is useful–the Release cue. Figure 4-25 shows this CCIP Release cue. This cue alerts you that the bomb will not release

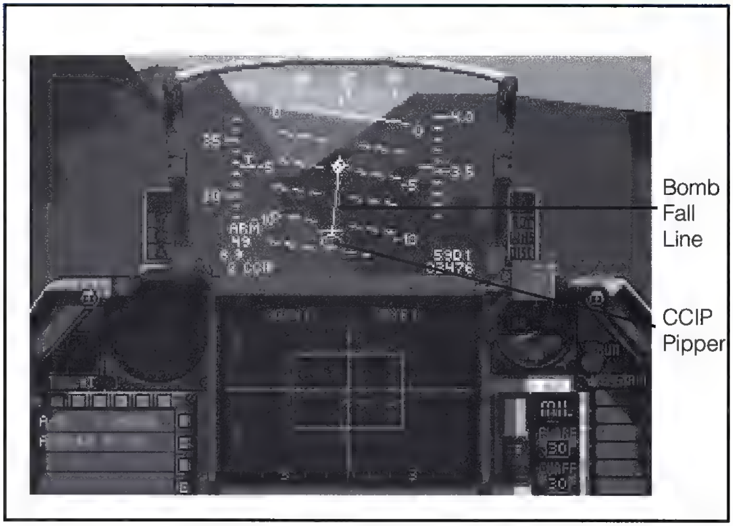


Figure 4-25.

The F-16A HUD and radar in ground attack configuration for bombing

immediately at pickle (release time) and you must continue to fly toward the target in order to get bomb release.

The Release cue, also called the Time Impact Bar, comes into view at pickle. It tracks down the HUD toward the Flight Path Marker to give you an indication of when the bomb will release. Bomb release occurs when the Release cue reaches the Flight Path Marker.

You will be able to *ripple* bombs as well, which means dropping more than one bomb on a target. The ' and ; keys will increase and decrease (respectively) the ripple count, which can range from 2 to 12 bombs dropped. You'll see the ripple number on your SCP as R (ripple number).

Lesson 7B starts you about 5,000 feet in the air heading due north toward ground targets. Start by selecting the Mk-82s in your SCP, and then nose your F-16 down to visually acquire the ground targets.

Line up your Pipper with one of the targets, such as a tank, and press the SPACEBAR to designate this target. Watch the Time Impact Bar; when it reaches the Center Point, the bombs will automatically drop. You can also drop the bombs manually by pressing the SPACEBAR again. Select your LAU 5003A rocket launcher and sight some more targets. The LAU Pipper is fixed in the middle of your HUD, so line up your Death Dot and fire away. Climb back to approximately 2,500 feet, select your M61A1 gun by pressing BACKSPACE and press P to pause Falcon 3.0.

Strafing

Strafing means to rake the ground with gunfire at close range. It's a good thing to do in an F-16 if you want to experience life as a prisoner of war. The 20-mm gun in the F-16 is an excellent air-to-air weapon, but it lacks the range and killing power to be an effective air-to-ground weapon.

You have to get very close to the ground in order to have a chance at hitting and killing a target and, at this low altitude, you are in range of a number of assault rifles (not to mention shoulder-launched SAMs) carried by a bunch of very mean grunts who have a large stake in the outcome of your attack. The high risk is usually not worth the low payoff associated with 20-mm strafe. There are, however, no absolute truths in fighter tactics. If you are down to just your gun, and you need to kill a ground target, then the Strafe mode is available to help you out. In Falcon 3.0 the gun is an effective weapon only for destroying soft air-to-ground targets.

Strafe HUD Symbology

Figure 4-26 shows the HUD symbology associated with strafe. You enter this mode by pressing the BACKSPACE key until "STRF" appears in the bottom-left corner of the HUD. The small Aiming Reticle or Pipper in the middle of the HUD is used to line up on the target. When the target is under the reticle, press the SPACEBAR (or joystick button 1) to fire. You will get the display shown in Figure 4-26.

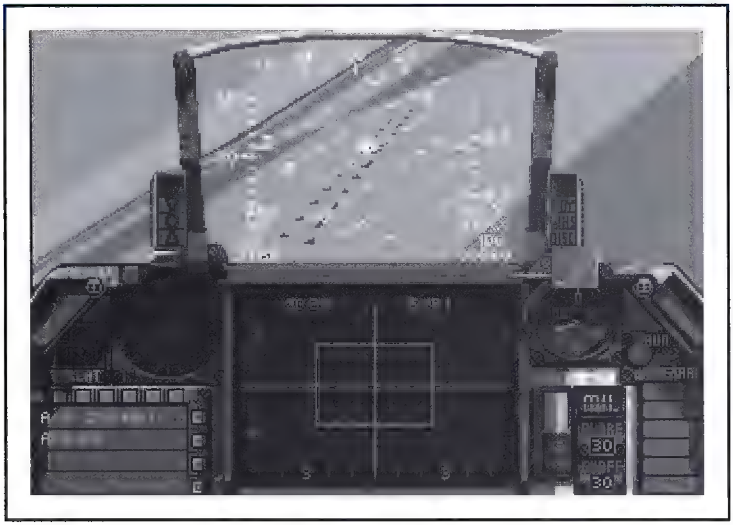


Figure 4-26.

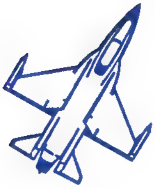
The F-16A HUD and radar in ground attack configuration, strafing tanks

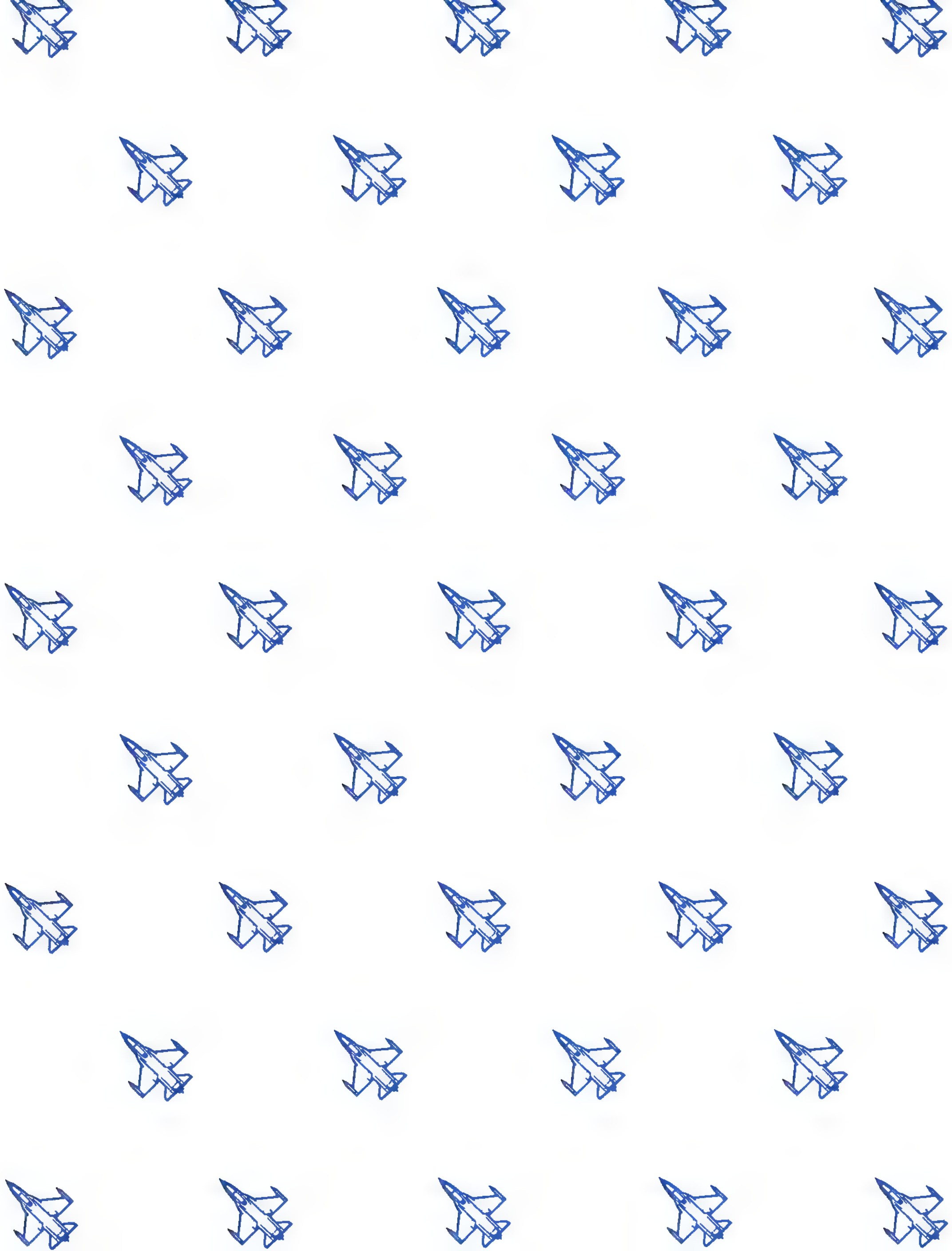
If you fly too low you will see the Break X indication. This symbol comes into view to warn you that important parts of your body and the ground are on a collision course. This Break X display is also appropriately called the Ground Clobber indication. When you see this X, you better do something about it (like pull up). The X consists of a > and a < moving towards each other; when they form an X, you've plowed. While rocketing towards the ground, you'll hear "Bitchin' Betty" tell you to "pull up!" Ignore her at your own peril.

Note: *You'll find that strafing those targets on the ground is not a particularly productive proposition. Still, if the M61A1 gun is all you've got, well, smoke 'em if you've got 'em; you'll have to make do.*

Conclusion

Falcon 3.0 can be a complex and frustrating simulation. Don't get mesmerized by all of the different weapons modes and HUD displays. Find a weapon you like to use, and practice until you become dangerous with it (to the enemy, not yourself). Ideally, you'll become proficient with all your weapons so you can survive a campaign while maximizing the number of mission objectives achieved. The objective in Falcon 3.0 is to quickly get into weapons parameters, destroy the target, and beat it. The next chapter will describe sensors and on-board countermeasures that will help you accomplish this objective.





CHAPTER

5

THE BRUTAL AMBUSH

"...the fighter with the largest killing zone dictates tactics to the enemy..."

–Col V. Babich
Soviet Fighter Pilot

Although high *G* maneuvering combat is important, historically only a small percentage of combat kills have occurred as a result of the classic dogfight. The chance of being ambushed today is many times greater than it was in the past, due to greater missile range and improved sensors (primarily radar).

You've already seen how your own missiles–air-to-air and air-to-ground–can acquire targets from several miles away, allowing you to stand off from your opponent. (That's why missiles are called *stand-off weapons*.) The goal in modern air combat is to use your radar to find the enemy and tear his lungs out with your stand-off weapons before he even realizes you're there. This may sound harsh, but rest assured he'll do the same to you if given the chance. Part of your job is not to give him that chance.

Situational Awareness

As a Falcon 3.0 pilot, you must have Situational Awareness–that is, you must be on top of all the elements of your particular situation–your speed, altitude, and heading, as well as your opponents' positions and headings. *Situational Awareness* (SA) is your ability to predict the future course of the air battle based on the information at hand. Situational Awareness is gained by listening to the radio, interpreting sensors such as radar, and looking out of the cockpit. A pilot with good SA is like King Kong, and has the ability to dominate the air battle. A pilot with poor SA is like Little Bo Peep, and has very little ability to influence the fight. The next chapters will cover specific Falcon fighting techniques that will help transform you from the hunted to the hunter. Your main tools are your radar and your eyes; this chapter helps you use both.

The F-16's Radar

Radar is an extension of your eyes and ears. If you enter today's arena without radar, you're blind. If you have good radar and you can't use it correctly, you should probably be dusting crops for a living instead of flying fighters.

The F-16 has a very effective pulse-Doppler "look-down" radar system that can detect targets beyond visual range at all altitudes. This radar system works in two basic modes—air-to-air radar, which is used during air-to-air engagements, and air-to-ground radar, which is used during air-to-ground combat. The radar scope presents the pilot with a wide range of target information that must be interpreted quickly and correctly in order for the pilot to kill the enemy and survive.

Falcon 3.0 Radar

Falcon 3.0 allows you to adjust the degree of realism in its radar simulation. There are three different air-to-air radar selections. *Situational Awareness Display*, or *SAD*, is the simplest radar selection and gives you a complete 360 degree view of all aircraft around you. The *Situational Awareness Mode*, or *SAM*, radar selection is a simplified version of a real F-16's radar capabilities. The *High Fidelity Radar*, or *HFR*, selection closely approximates the actual F-16 APG-66 radar system. The following sections discuss each radar selection in more detail. To choose a radar type, enter the Config screen from the War Room. Then click on the three-way switch just below the Radar control in the lower-left corner.

As explained in Chapter 4, Falcon 3.0 radar information is displayed on the REO (Radar/Electro-Optical Display). You should toggle your radar to standby by pressing R, and only turn it on intermittently to search for enemies.

For instance, turn your radar on, scan the area in a large sweep and then shut down. If you receive a contact (blip) on your REO screen, then narrow the sweep and try to get a rough estimate of the enemy's position (range, altitude, and so forth), and then shut down. Don't give the enemy the chance to pinpoint your location. Since your radar must bounce a signal off of the enemy aircraft, he will receive a warning on his Threat Warning Indicator before you get the return (blip) on your REO screen. If the target is several miles away, then the time between sweeps should be greater than if it is at a closer range.

The next sections examine the three radar selections in Falcon 3.0, and teach you how to use them in air-to-air engagements.

Air-to-Air Radar

As a Falcon 3.0 pilot, you must always be looking for the enemy, using both your eyes and your radar. The enemy that will get you is the one you don't see. The following sections explain how to use SAD, SAM, and HFR radar.

Situational Awareness Display (SAD) Radar

Situational Awareness Display (SAD) radar mode, shown in Figure 5-1, provides a top-down, bird's-eye, unlimited view of your area. This mode is good for the novice pilot trying to grasp and master Situational Awareness. In SAD mode, the radar is always in auto-lock, which means it will lock-on to the closest target that enters its scan volume. (*Scan volume* is the amount of sky you are searching.) Figure 5-2 depicts the

Figure 5-1.

Air-to-air radar in SAD mode

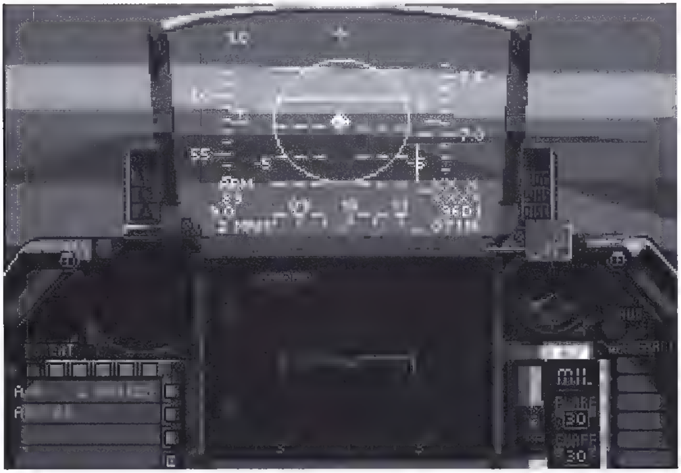
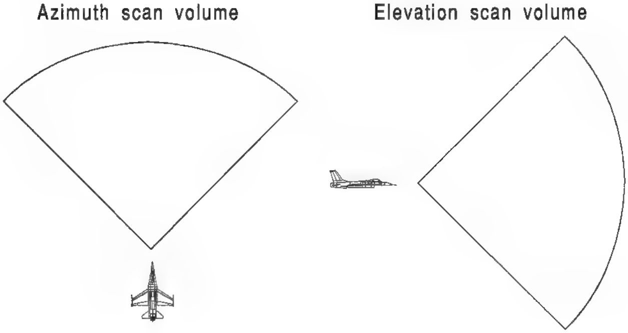


Figure 5-2.

Radar azimuth and elevation search volumes



azimuth (horizontal radar sweep) and elevation scan of the F-16 radar. In SAD mode, unlike the limited volume shown in this figure, the search volume extends 360 degrees around your fighter.

There are two modes of SAD radar in the simulation: search mode and lock-on mode. You'll look at each next.

The SAD Search Mode

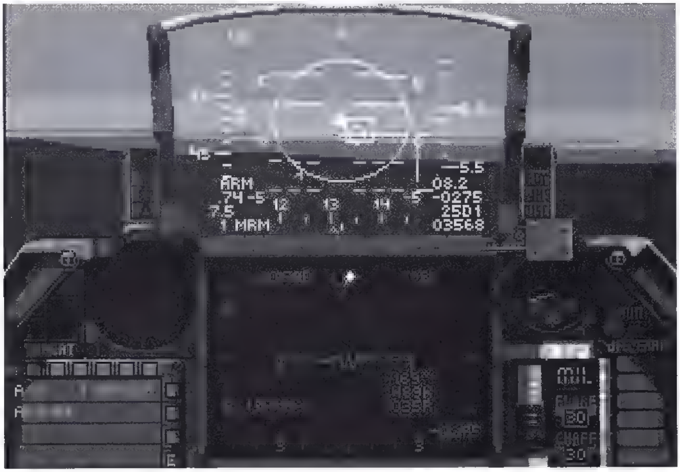
In the SAD search mode, shown in Figure 5-1, the radar has not acquired a target, so no target information is presented. An *Artificial Horizon Line* is located in the center of the radar and runs horizontally across the scope. This gives you an indication of aircraft roll when you're using the radar scope.

The SAD Lock-on Mode

The second SAD radar mode, shown in Figure 5-3, is the lock-on mode, which occurs when the radar finds the nearest threat and automatically locks on. Radar lock works in con-

Figure 5-3.

Air-to-air radar in SAD mode with a bogey locked up



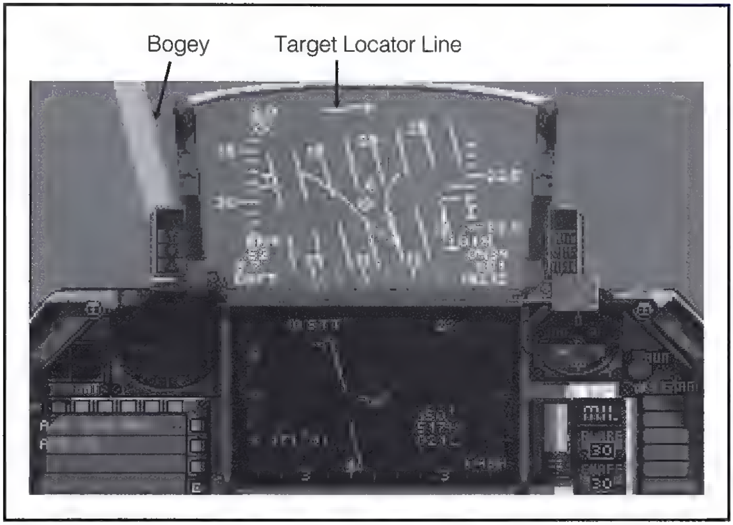
junction with the Target Designator (TD) Box located in the HUD, which appears around the target when the radar is locked on and the target is in the *field of view (FOV)* of the HUD. If the radar is locked on and the target is *not* in the field of view, the Target Locator Line will appear at the Gun Cross and point in the direction of the target. Figure 5-4 shows a HUD display with the Target Locator Line present. (Refer to Chapter 4 for a review of how the TD Box, Target Locator Line, and Gun Cross function.)

Radar Scope Information

When your radar is locked on to a target, it gives you detailed information about that target. Figure 5-3 shows the radar scope in the SAD radar lock-on mode. The target appears as a diamond in the top-middle of the scope. If your radar is illuminating multiple targets, the designated target–the target that the radar has locked on to–becomes a diamond. All other radar contacts will be depicted as small squares on your REO screen. You can cycle among designated targets by pressing

Figure 5-4.

HUD showing the Target Locator Line pointing towards the bogey



the T key. Each designated target will become a diamond in turn.

***Note:** Your aircraft position is depicted in the center of the REO. Also note that the color of the blip conveys information about the bandit's relative position to you. A yellow blip means the target is more than 3,000 feet below you. A blue blip means it is more than 3,000 feet above you. A white blip means it is within 3,000 feet of your F-16, either above or below you.*

The Fire Control Computer In SAD radar mode, your Fire Control Computer will automatically choose the proper radar range, which can be 10, 20, 40, or 80 nautical miles (nm). Your current radar range is the number preceding the letters "SAD" in the upper-left corner of your REO. You are in the center of the REO; in 10 SAD mode, any bandits appearing at the edges of the REO are approximately 10 nm away.

Let's review the other information displayed in the radar scope in the lock-on mode shown in Figure 5-3.

The Target Bearing The Target Bearing gives your relative bearing to the target in degrees. It is the number in the lower-left corner of the radar scope. In Figure 5-3, the Target Bearing is 134°. (The Target Bearing is discussed in detail in Chapter 4.)

The Target Range The Target Range tells the range to the target in miles. It is presented in the lower-left quadrant of the radar scope, just to the right of the number showing the bandit's bearing. In Figure 5-3, the Target Range is 8 miles.

The Target Altitude The Target Altitude gives the altitude of the target in thousands of feet. This information is located at the top-right of the screen, to the right of the indicator showing your radar mode. In Figure 5-3, the altitude of the target is 06, meaning 6,000 feet.

The Target Heading The Target Heading gives the heading of the target in degrees. The Target Heading is the top number in the target information block in the lower-right part of the scope. The Target Heading is 169° in Figure 5-3.

The Target Speed The target's speed in knots per hour is the middle number in the target information block in the lower-right part of the scope. In Figure 5-3, the Target Speed is 489K, denoting 489 knots per hour.

The Target Aspect Angle Target Aspect Angle is the most important information presented by the radar. It is the bottom number in the target information block, and is followed by either an *L* or an *R*, which denotes left or right aspect. In Figure 5-3, the target has 35 degrees of right aspect. Target aspect is very important, but can be difficult to understand at first. It will be discussed in greater detail later in this chapter, in "More on the Target Aspect Angle."

The Target Closure Rate (Vc) The Target Closure Rate (Vc) is a measure in knots of how fast you are closing in on the target. This number is located in the bottom-right corner of the REO. In Figure 5-3, the Vc is −0275 knots; a negative number means the bandit is pulling away from you. An extremely high Vc is indicative of a head-on intercept.

More on the Target Aspect Angle

If you've selected an air-to-air missile, you'll see your Missile Aiming Reticle. An aspect caret appears on the Missile Aiming Reticle when the radar is locked on and you are in the Sidewinder missile mode. This aspect caret gives you the same target aspect information that is presented in the radar scope. The caret slides around the Missile Reticle to indicate aspect angle.

The following list describes a few different positions of the aspect caret on the Missile Reticle and the target aspect that these positions represent:

Aspect Caret Clock Position	Aspect Angle
twelve o'clock	180°
three o'clock	90° left
six o'clock	0°
nine o'clock	90° right

Situational Awareness Mode (SAM) Radar

SAM radar in Falcon 3.0 is a more realistic simulation of the F-16's APG-66 radar abilities than SAD radar. SAM radar scans a cone 120 degrees horizontally and vertically in front of you, similar to the diagram radar azimuth and elevation search volumes in Figure 5-2. Therefore, you will only track targets that are within this cone, which appear as green squares on the radar screen. Keep in mind that SAM radar has a 240 degree blind spot.

As with SAD radar, your Fire Control Computer will select the proper radar range. However, your aircraft's position is now depicted at the bottom of the REO (as opposed to SAD where you were at the center of the REO). Therefore, if your REO reads "10 SAM," that means a bogey at the top of the REO is 10 nm away; a bogey at the bottom of the REO is right on top of you. As in SAD mode, the radar is always in an auto-lock mode and will lock-on to the closest target that enters its scan volume.

***Note:** The aspect caret can be anywhere on the Missile Aiming Reticle when the radar is locked on to the target. It is important that you learn to read the aspect caret at this point in your training because when you switch to the Padlock view to engage your enemy, you will not have your eyes on your radar screen. Therefore, you should learn how to infer target aspect by reading the aspect angle caret on the Aiming Reticle.*

High Fidelity Radar (HFR)

HFR, or High Fidelity Radar, is the most realistic radar mode available in Falcon 3.0. If you decide to use HFR, you'll begin to get an idea of how much an F-16 pilot has to keep track of while in the cockpit.

HFR has four submodes that you can switch to in various situations. These are NAM (Normal Air Mode), SAM (Situational Awareness Mode), STT (Single Target Track) mode, and ACM (Air Combat Maneuvering) mode. You use NAM to search for targets, STT to lock-on to a target, SAM to gain specific information about targets you've locked on to, and ACM to automatically lock-on to all targets within 10 nm. These submodes will be explained in more detail in the next sections.

NAM Radar Mode

The NAM radar mode, identifiable by the word *AIR* displayed in the upper-left corner of your REO screen, is the search mode for HFR radar. It allows you to search for targets without locking on to them and thereby giving away your location.

NAM allows you to focus your search by controlling your antenna azimuth (horizontal radar sweep) and your elevation scan. You control your horizontal radar sweep by pressing F9, which cycles among forward radar sweeps of 20, 60, and 120 degrees. Note the change of the "T" movement on your bottom grid, which corresponds to the movement and range of motion in degrees of your radar antenna.

You toggle your elevation, or vertical scan, by pressing F10. You can select 1, 2, or 4 bars of elevation. A 1-bar elevation means your radar will only move left to right. This is obviously the narrowest radar band. A 2-bar scan has the radar moving left to right, but dropping down after a left-to-right horizontal sweep, then moving up after the return right-to-left sweep. A 4-bar scan means the radar drops after a left-to-right sweep, drops again after the return right-to-left sweep, drops again after another left-to-right sweep, and returns to its original position after one more right-to-left sweep. As you cycle through your elevation scan, you will see a number in the upper-right corner of your REO. This number indicates altitude scanning range in thousands of feet.

Why should you ever use the narrow band? Why not always keep your radar on 4-bar scanning? Well, each target blip on your REO is updated when your radar scans them. Therefore, the narrower the scan, the less time each sweep takes and the more continuous the radar information is on each bandit. A wide scan will track more targets, but will provide an update on each target more slowly. Getting fast updates is important in NAM mode since a target will leave a trail of blips on your REO; the fainter the blip, the older the position. Therefore, you can track a target's movement by the pattern it leaves on your REO. This tracking is called *target history.* The smaller the scan volume, the more often you can paint each target with your radar.

***Remember:** To check whether a target is a bandit or a friendly, use your IFF (Identify Friend or Foe) device by pressing N; if you hear a squawk, or see the IFF light illuminate, it's a friendly.*

You enter NAM by pressing F5. Your NAM radar starts out at a scanning range of 20 nm, but you can cycle through your options by pressing F8. As in other radar modes, the distance from the top to the bottom of the screen corresponds to your radar range. If there's a target in the middle of your REO, and the range setting is 20 nm, the target is 10 nm away from your position.

In NAM, you acquire your target with the *acquisition corral*. This will give you more information about the target and set you up to lock-on to it. Press T to acquire your target, and your radar blip will be bracketed with a little vertical line on either side of it. As soon as you corral the bogey, the Search Altitude Bar will appear on the left grid on your REO. This vertical bar will give you an idea of the approximate altitude of your corralled bogey. See Figure 5-5 for an example of HFR radar in NAM mode.

***Remember:** The centerpoint on the left grid of your REO is sea level, and each tick represents 10,000 feet of elevation. The 3 represents an altitude of 30,000 feet.*

SAM Radar Mode

Now that you've corralled a target in NAM mode, it's time to get down and dirty. Press Z to switch to SAM radar. The blip will become a diamond, meaning you are actively tracking the target (see Figure 5-6). You cycle through your available targets by pressing T, or you can press X to return to NAM radar. SAM radar is especially useful since it allows you to monitor the stats on one target while your radar is scanning other targets. See "Situational Awareness Mode (SAM) Radar," earlier in this chapter, for more information on SAM radar. Whether you select SAM radar from the beginning or switch to it while within HFR, it works the same.

Single Target Tracking (STT) Radar Mode

If you've identified a target to be a bandit and not a friendly, you may choose to radar lock the bogey. Press Z again and you'll enter STT mode (shown in Figure 5-7) and establish radar lock on the target. Your REO will give you continuous updates on your locked bandit, but remember that the bandit will probably get a "LCK" threat warning and take evasive action.

Figure 5-5.

Radar in NAM mode with a target designated prior to STT lock. Notice the multiple blips belonging to the single target, depicting target history

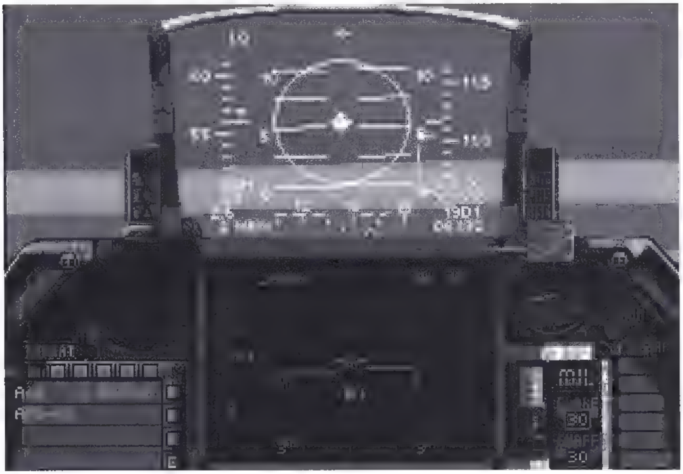


Figure 5-6.

Radar in SAM mode

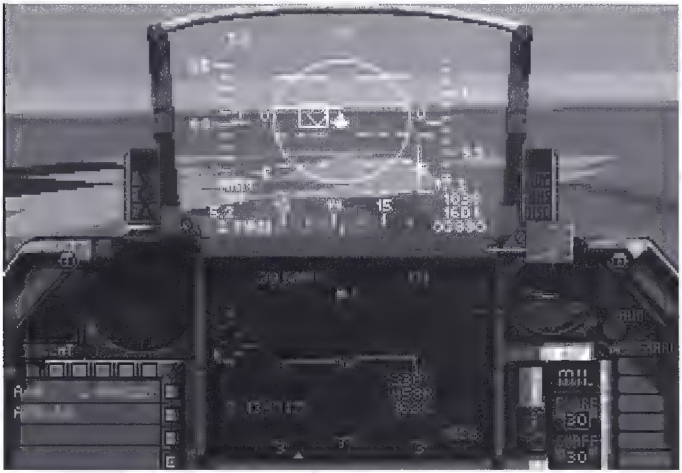
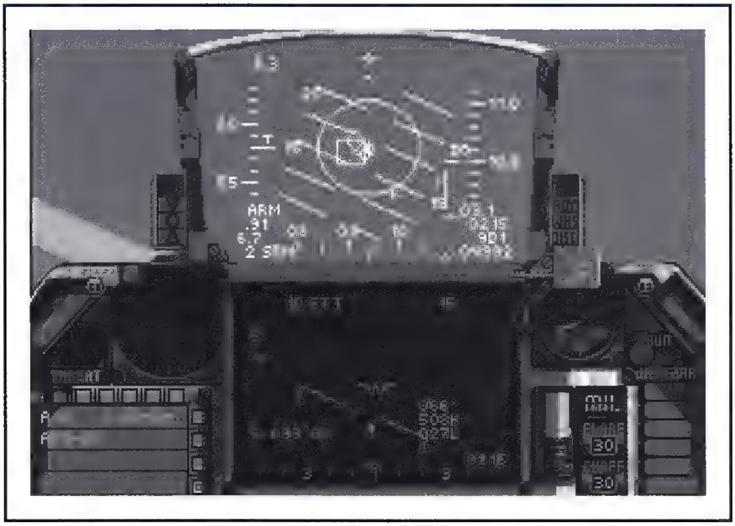


Figure 5-7.

Radar in STT mode



Air Combat Maneuvering (ACM) Mode

You can automatically lock-on to targets within 10 nm by choosing Air Combat Maneuvering (ACM) radar mode, which is essentially identical to STT mode, except that it automatically acquires radar lock on the closest target. You enter ACM (shown in Figure 5-8) by pressing F6. When you're in close with multiple targets, use ACM to automatically search for and lock-on to the nearest threat. As soon as the target is locked, you will be switched to STT mode. ACM is especially useful when you are in close and have switched to guns.

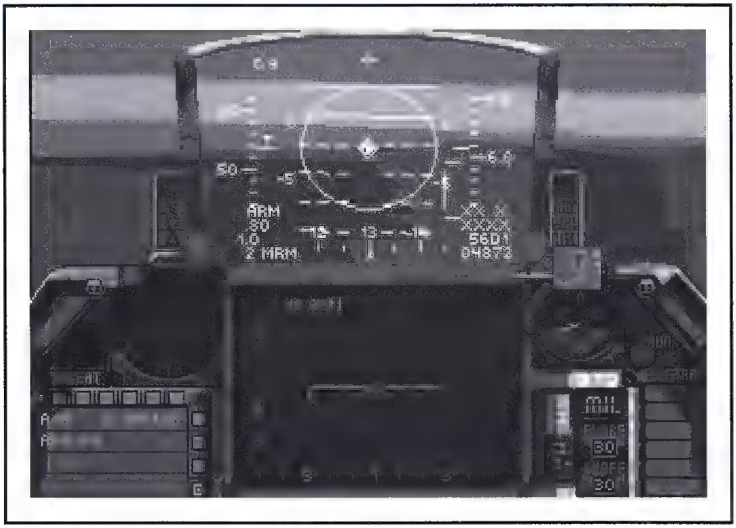
***Note:** ACM mode is useful when you're in close with multiple bogeys and you don't have time to manually select your targets.*

Choosing Which Type of Radar to Use

HFR gives you manual control of the different radar modes within it (NAM, SAM, STT, and ACM), while SAM and SAD radar are controlled for you automatically. If HFR seems too complicated at first, choose SAM radar to acclimate yourself, or even SAD radar to optimize playability. Move up to the more difficult radar selections as you become proficient—if you

Figure 5-8.

Radar in ACM mode, no targets acquired



can't infer information from your radar, then its useless to you.

Air-to-Ground Radar

The *Ground Map* radar mode is used during air-to-ground engagements. You can use it to identify the terrain you are flying over by using rivers (which appear as bright green lines), roads (which appear as dimmer green lines), and buildings (which appear as green dots), as reference points. You can toggle off the Roads/Rivers display by pressing Y.

Press F7 to switch from your air-to-air radar to your ground radar, regardless of which type of air-to-air radar you have selected from the Config screen. Figure 5-9 shows an example of the REO in Ground Map mode—note the letters "GM" in the upper-left corner indicating this mode. Your ground Map radar range is 20 nm, but you can zoom in on

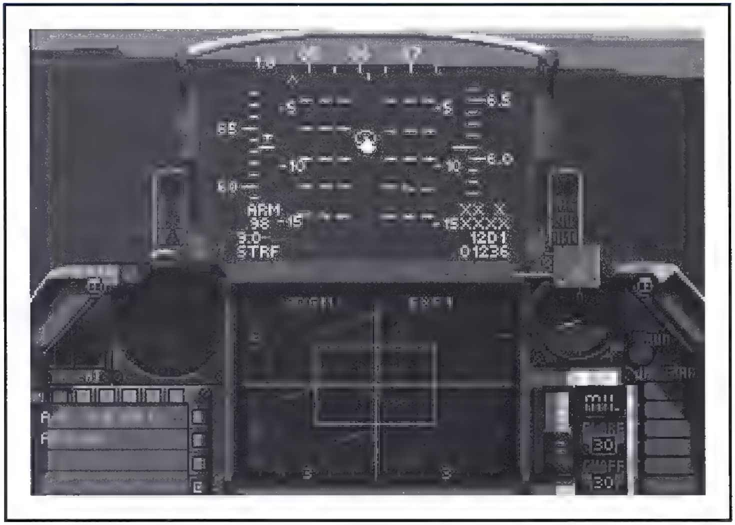


Figure 5-9.

The REO in Ground Map mode

Note: *The bearing and distance of any selected ground targets will appear in the lower-left quadrant of your REO, and will be highlighted when the targets come in range of your Ground Map radar.*

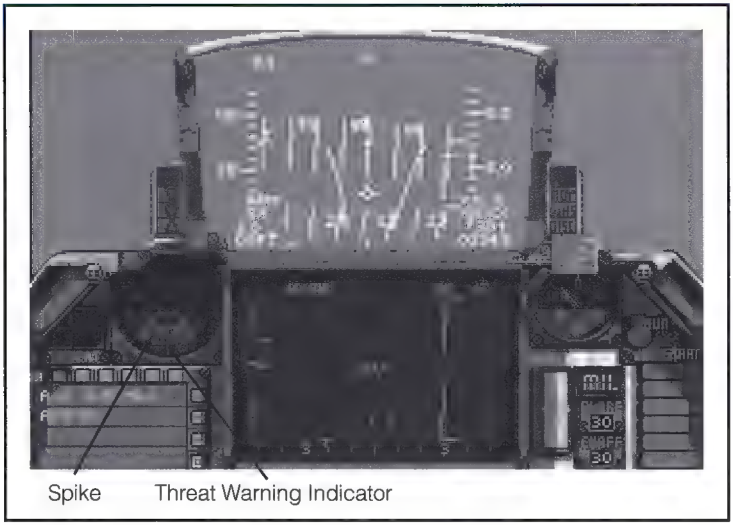
the rectangular zone to 2X, 4X, 8X, or 16X magnification by pressing F1, or zoom out by pressing F2. The rectangle at the center of your Ground Map radar display can be moved around by using a combination of the SHIFT key and the arrow keys, allowing you to zoom in on any part of the radar display.

The Threat Warning Indicator

The Threat Warning Indicator (TWI) is a sensor that, like your radar, you use to increase your overall Situational Awarness during an enemy engagement. The TWI is shown in Figure 5-10. It consists of a circular scope adjacent to warning lights that illuminate when an enemy missile locks on and launches. In addition to these lights, you will hear a beeping tone to indicate enemy radar lock-on, and a short scratching tone to indicate enemy missile launch.

Figure 5-10.

The Threat Warning Indicator showing active radar contacts



Interpreting Threat Warning Indicator Signals

The Missile Lock Light is seen on the Threat Warning Indicator Warning Panel as a flashing "LCK." This indication tells you that a radar-guided missile has locked on to you. The lock ("LCK") indication always precedes a missile launch ("LNH") indication for radar-guided missiles. When an enemy missile is launched with your name on it, you will receive a flashing "LNH" indication on the Threat Warning Indicator Warning Panel. If you get a *missile launch* indication without first getting a *missile lock* indication, then you are being engaged by a IR-guided SAM.

The Threat Warning Indicator is divided into quarters. Imagine that your wingspan forms the horizontal diameter line of the circle. The top half of the circle is your forward viewing half of your F-16 (from your wingspan up), while the lower half represents the lower half of your airplane.

The circular display of the Threat Warning Indicator will show bandits or missiles at the correct relative azimuth with your jet in the center of the scope. A threat at the six o'clock position indicates that a bandit is right behind your aircraft. The Threat Warning Indicator will show every airborne threat to your aircraft, and can also be used to get a bird's-eye view of the air battle.

Within the Threat Warning Indicator you may see different types of threats. A diamond means an enemy plane is within 30 miles of your F-16. The number in the diamond corresponds to the radar band the plane is emitting, from which your computer can guess the configuration of the enemy aircraft, as mentioned earlier. A large green square means a radar installation is tracking you. Surface-to-air radar is one of two types: a number 1 in the square means the radar is continuous wave/Doppler; a number 2 means it's pulse-Doppler radar.

Continuous Wave/Doppler Radar

Continuous wave/Doppler radar (CW radar) emits a constant signal and requires one antenna for transmission and another for reception of the reflected signal. CW radar is only effective against aircraft moving toward or away from it; if your F-16 is moving at a 90 degree angle to the radar installation there is no Doppler shift, and the radar does not pick you up.

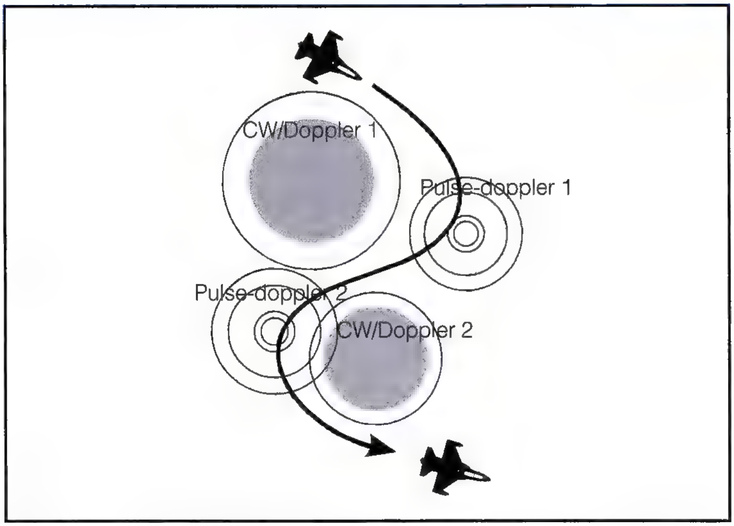
Pulse-Doppler Radar

Pulse-Doppler radar emits a signal in pulses, and also requires separate transmission and reception antennae. This type of radar is less efficient than CW radar, but excellently tracks the type of movement CW radar misses. The best way to fool pulse-Doppler radar is to fly directly into the pulse-Doppler signal, since such radar picks up everything it bounces a signal off of and generates excessive "snow" on the enemy's radar display.

Figure 5-11 shows how you can approach multiple radar sites to minimize your chances of being picked up. You fly at a 90 degree angle near CW radar sites and straight toward and away from pulse-Doppler radar sites. This type of maneuver is called threading the needle.

Figure 5-11.

Threading the needle



Types of Air-to-Air Radar

There are six types of air-to-air radar you may encounter. When you are being illuminated by an enemy aircraft's radar, as shown in Figure 5-10, it will show up as a *spike*, or diamond, on your Threat Warning Indicator. The spike will be labeled with a number from 1 to 6. Here's what those numbers mean:

- 1 indicates multiple-tracking, look-down, shoot-down radar, found in a MiG-29 or Su-27
- 2 indicates Single Target Tracking radar, found in a MiG-23, MiG-25, or MiG-27
- 3 indicates CW radar, found in a MiG-21
- 4 indicates targeting radar, found in a Mirage III, Mirage 5, or Mirage F1
- 5 indicates attack radar, found in an Su-24

- 6 indicates early warning radar, found in early warning AWACS-type aircraft such as an IL-76

Finally, a small green square means a missile has been launched within 30 miles of your F-16—and it has your name on it.

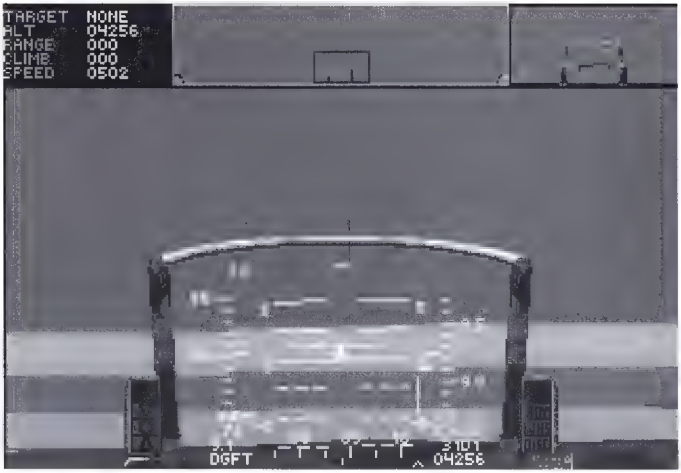
Padlock View

When it comes down to dogfighting, there is no instrument better than your eyes. Hence the old aphorism, "lose sight, lose the fight." This rule hasn't changed since fabric-covered wooden crates dueled in the air during World War I. When you are in visual range of your target, you *must* keep your eyes on it. This way you'll be able to tell if the bandit climbs or dives, his bearing, and whether he turns.

Unless you become disoriented, your eyes are the best way of keeping track of your enemy in close aerial engagements. The real F-16's bubble canopy is designed to maximize the pilot's view. Falcon 3.0 allows you to simulate a pilot's nearly unobstructed 360 degree view around the F-16. You have the left, right, and rear cockpit views, but they are not effective in combat. Pressing the SCROLL LOCK key allows you to view more of the sky in any of these views, and is helpful in combat, especially from your front cockpit view, but Padlock view is the most realistic cockpit view you can use.

"Padlocking" a bandit means keeping visual "lock" on the bandit; the target cannot fly out of your view. The view will default to the nearest threat, but you can cycle through any WVR (Within Visual Range) targets by pressing the T key. Press 8 to switch to your Padlock view, which is shown in Figure 5-12. The display is divided into four sections: the Padlock Status window, the 360 Degree window, the Target Locator window, and the Main Padlock window. Each is covered in the following sections.

***Remember:** During a dogfight in the Padlock view you may become visually disoriented and lose track of your position relative to the ground. In situations like this, revert back to the full cockpit view.*



TARGET NONE
ALT 04256
RANGE 000
CLIMB 000
SPEED 0502

Figure 5-12.

Padlock view

The Padlock Status Window

In the upper-left corner of your screen you'll see the Padlock Status window, which displays basic information on your target such as its altitude, range, climb rate, and airspeed. The identity of the bogey appears here when you fly within identifying range. (When you're within range, your computer can make an educated guess about the configuration of the enemy aircraft based on the radar signals it emits.)

As sophisticated as this identifying technology is, a human pilot in an F-16 has a 360 degree view out of the cockpit, and the human eye can see details in the real world that current graphics technology cannot duplicate. Therefore, a real pilot would be able to identify a bogey that would still be indistinguishable on even a VGA display. Falcon 3.0, however, partially overcomes the problem of a limited view from the cockpit by providing you with additional displays and information that are in some ways better than their real counterparts in the F-16.

Note: *When you are in a dogfight, the Padlock view can be extremely disorienting. The Target Locator window helps you maintain your orientation during such an enemy engagement, but you may wish to train for the Padlock view by using the foward view and toggling it to a forward-up view with SCROLL LOCK.*

The 360 Degree Window

In the top center of the display is the 360 Degree window. This simulates the 360 degree view out of an F-16 cockpit as the display wraps around from the left edge to the right edge. The red rectangle indicates where the main Padlock View is relative to your F-16. The red cross inside the red rectangle indicates the position of the padlocked bandit.

The Target Locator Window

In the upper-right corner of your screen is the Target Locator window. This is a miniature display of the bandit, your HUD, and an Artificial Horizon Line so you can keep track of your F-16's position and put your lift vector on the bogey. If the bogey is on your six, you won't see the HUD but you'll see the word *Rear* superimposed on your Target Locator window. As on your main HUD, your miniature HUD has a red target indicator line that helps you steer toward your target.

The Main Padlock Window

Taking up most of your screen is the main Padlock window. This view corresponds to the red rectangle in the 360 Degree window. A small red square appears in your main Padlock window that tracks your targeted bogey. If you maneuver so that the bogey is within forward view, you'll see your HUD and Missile Aiming Reticle, and acquire missile lock on your bandit.

Learning to Use the Padlock View

Lesson 7A

To get used to the Padlock view and the various radar modes, return to Lesson 7A in Chapter 4, where you engaged the three Mirage IIIs and the lone MiG. Don't follow the flight plan given in Chapter 4, but rely on your radar to acquire targets, and your Padlock view to get the bandit in visual lock. Bank into some turns and get the feel of your Padlock view. It may be the most valuable option during air combat, and is instrumental in keeping bandits *off* your six, and keeping you *on* their six.

If bandits get on your six o'clock, lower your airspeed to around 450 kph and pull a high *G* turn to get at least one of them in your sights. After you've become comfortable with using your Padlock view and radar, try Lesson 8. Your Padlock view will be instrumental in the multiple-bandit engagement against a MiG-23 and a MiG-27.

Lesson 8

Interception

Interception is the art of starting a fight from Beyond Visual Range (BVR) and converting your sensor information into dead bandits. The two F-16 sensors used in Falcon 3.0 are radar and the Threat Warning Indicator. The following section will describe the geometry and techniques of using sensors to perform intercepts.

Intercept Geometry

If you understand target aspect you will understand intercept geometry. If you don't, you will be like Columbus, wandering around aimlessly, hoping something good will happen to you–and it probably won't. *Target aspect*, as mentioned earlier, is simple to define but tough to understand. It is defined as a measure in degrees from the tail of the target to your jet.

In Figure 5-13, the target is on the nose of the F-16 at approximately 135 degrees left aspect. Figure 5-14 shows a cockpit view of the same geometry. Note the target aspect in the HUD and in the radar scope.

Your aircraft heading does not have anything to do with measuring aspect angle, which is determined by the heading of the target only. Aspect angle is important because you instantly know your position in relation to the target when you know aspect angle. If, for example, the HUD indicates 180 degrees of aspect, you know that you are on the target's nose. Your aircraft may or may not be pointing at the target, but

Figure 5-13.

Target aspect angle, F-16 pointing at target

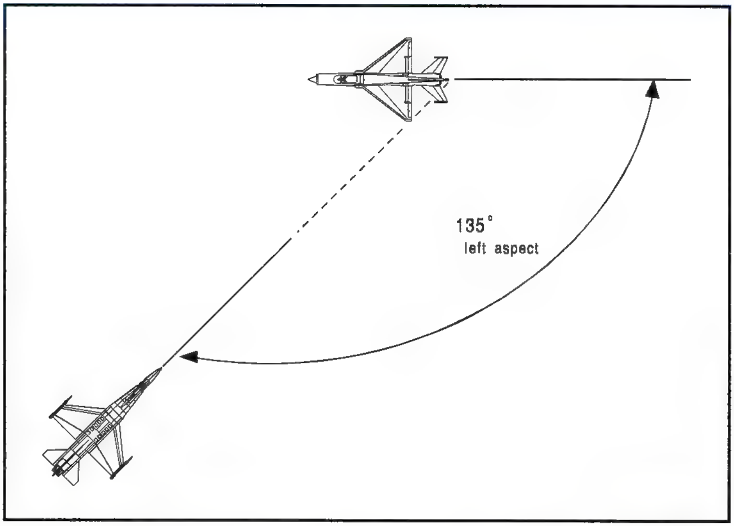
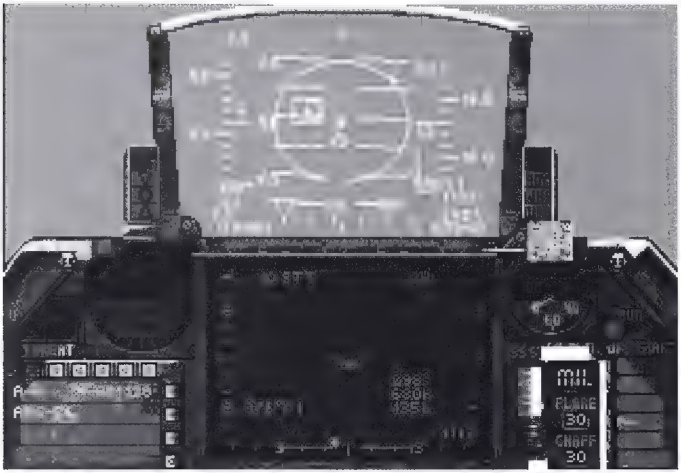


Figure 5-14.

What a bogey looks like in the HUD and on the REO, target aspect angle at 135 left



you definitely know that your enemy is pointing at you. Figure 5-15 shows the same aspect angle as Figure 5-13, even though your aircraft heading is different. Figure 5-16 shows various target aspect angles and the corresponding position of your aircraft.

Intercept Techniques in Falcon 3.0

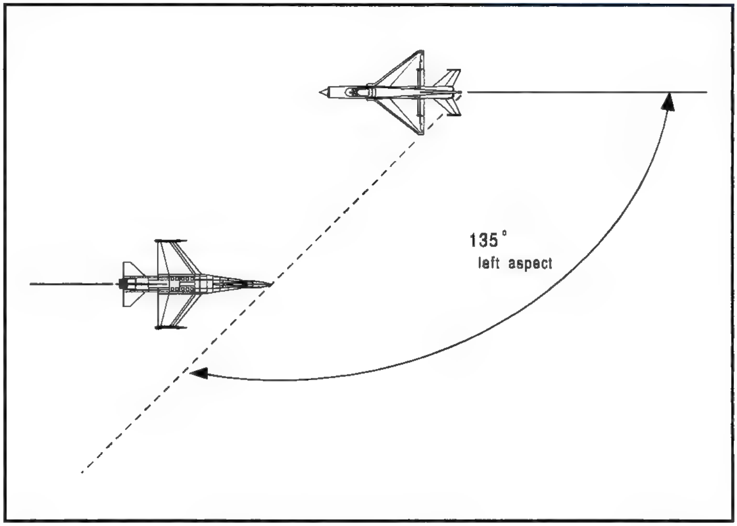
Now that you have been introduced to target aspect, you will go through some actual intercept techniques. Intercepts are used to arrive at a position of advantage on the target from any distance outside visual range. If you see the bandit, you perform Basic Fighter Maneuvers (BFM) and not intercepts (see Chapter 6 for more information on attacking). Intercepts are flown in phases; the following sections explain each step.

The Detection Phase

In the detection phase you are looking for the bad guys. In Falcon 3.0 you initially detect the bandits in one of three ways:

Figure 5-15.

Target aspect angle, F-16 pointing away from target



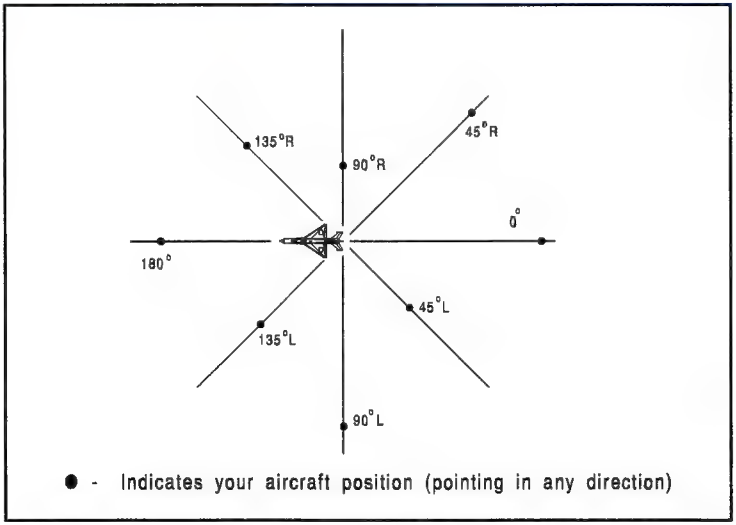

135°R
90°R
45°R
0°
180°
45°L
135°L
90°L
● - Indicates your aircraft position (pointing in any direction)

Figure 5-16.

Various target aspect angles and the associated position of your aircraft

- *You pick up the target on your Threat Warning Indicator.* This is the worst way to detect a target, but any detection is better than no detection. When you see a target on the scope, turn the jet in the direction of the target and roll out of the turn when the target is on the nose (at the twelve o'clock position on the Threat Warning Indicator scope). The target will now be in the scan volume of the radar and you can get a radar lock.

- *Your radar detects the target.* This is the best way simply because it's the easiest. After all, the objective of the detection phase is to get a radar lock-on. When you accomplish this, move on to the next phase.

- *The AWACS aircraft or your wingman tells you about the target.* They will give you the range, altitude, and bearing to a target. For example, AWACS might tell you that the bandit is at 9,000 feet on a bearing from your aircraft of 230, 19 miles away. Using this information, if you steer your jet to 230 degrees, you should pick up a blip on your radar.

The Radar Interpretation Phase

In the radar interpretation phase your radar is locked on to the target, and you must analyze the intercept geometry. To determine the geometry of the intercept, note the target aspect angle and range. If the aspect is *high* (above 120 degrees) you are in the target's *front quarter* (near the target's nose) and are performing a *head-on* intercept.

If the aspect is *medium* (60 to 120 degrees) you are at the target's three or nine o'clock position (depending on left or right aspect). If a medium aspect situation develops, you will roll out behind the bandit if you accelerate to catch him. This occurs because at medium aspect you start in the target's three or nine o'clock position and the target's forward motion will soon put you behind him.

If the aspect is *low* (0 to 60 degrees), you are in the *stern quarter* (near the target's tail). Since in this case you are already behind the bandit, all you have left to do is accelerate and close the range. Execute the following specific steps based on how far away the target is.

If the Target Is Inside Ten Miles

If you are within ten miles of the target and your radar is locked on to that target, put the target on the nose by turning in the direction of the Locator Line in the HUD. For example, Figure 5-17 shows the Locator Line (at the very top of the HUD) pointing to the right.

You roll the aircraft into a right bank and turn to the right until the Locator Line turns into a Target Designator Box around the target. Look at the target's altitude and airspeed while you are in the turn. You should climb or descend to be within 1,000 feet of the target's altitude. In addition, adjust your speed to fly approximately 50 knots faster than the target. If the target is at 350 knots, for example, fly at 400 knots. These altitude and airspeed changes are made

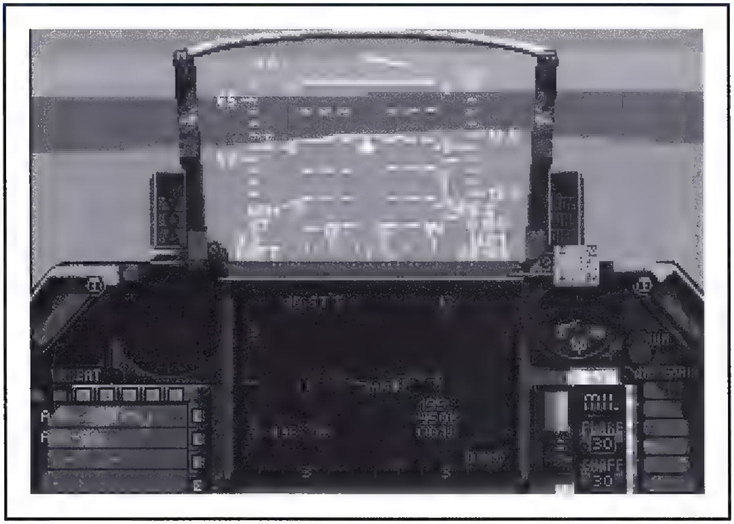


Figure 5-17.

HUD showing Target Locator Line pointing towards a bogey

so that you do not have to make large throttle and stick inputs when you sight the bandit at close range.

The American Bell X-1 was the first manned supersonic airplane. On 14 October 1947, Chuck Yaeger broke the speed of sound with the second prototype of this craft.

If the Target Is Outside Ten Miles If you are outside ten miles of the target at radar lock-on, you must analyze the geometry in order to perform an intercept. Look at target range, airspeed, altitude, and aspect angle. The same airspeed and altitude adjustments that apply for targets inside ten miles apply for targets outside ten miles. Descend or climb to 1,000 feet from the target's altitude and change airspeed to fly 50 knots faster than the target. Once you get your altitude and airspeed set, you have to analyze the aspect angle to get a grip on the intercept geometry. There are several ways to intercept the MiG in Falcon 3.0. The following techniques are based on actual intercept tactics, but they're not the only techniques available.

If the Aspect Angle Is 120 Degrees or Less If the aspect angle is 120 degrees or less, turn to put the target on your nose and accelerate to get 100 knots of Vc on the target. As was mentioned earlier, this number is read at the bottom-right corner of the radar scope (refer to Figure 5-3). You have already adjusted your airspeed to fly 50 knots faster than the target so this won't require a big throttle change.

If the Aspect Angle Is Greater Than 120 Degrees If the aspect angle is greater than 120 degrees, note your heading and turn 30 degrees opposite the target aspect to get *lateral displacement*, or turning room, on the target. For example, if the aspect is 150 degrees right, turn 30 degrees left. This turning room is the distance you need to be from the target to convert to its six o'clock. Figure 5-18 shows a bird's-eye view of the intercept and why you turn opposite the target aspect. In Figure 5-18, if the F-16 turned in the same direction as the aspect angle, the jet would decrease lateral displacement and would pass the bandit head-on instead of rolling out at the target's six o'clock.

After completing this maneuver, the range will decrease. When you're eight miles from the target, turn to put the target on your nose. If the aspect angle is medium to low, you are converting to the bandit's stern quarter. The enemy MiGs in Falcon 3.0 have a nasty habit of running an intercept on you at the same time you're intercepting them. If this happens, the aspect will stay high and you will pass them head-on (at high aspect). Chapter 6 will discuss maneuvering after a head-on pass.

If the target is not maneuvering against you, the turn you made opposite the target aspect will give you lateral displacement and allow you to convert to the MiG's six o'clock.

The Kill Phase

At some point during the intercept, your bandit will appear in a TD Box. When you achieve missile lock, shoot. The whole idea behind the intercept is to place your jet in a position to

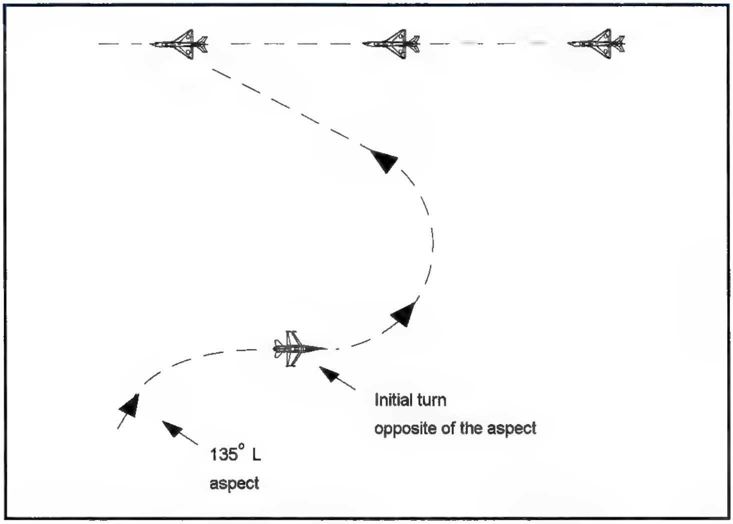


Figure 5-18.

A bird's-eye view of the intercept

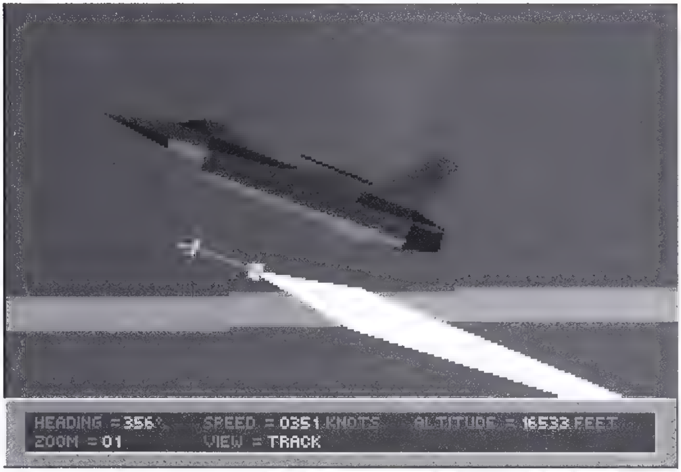
kill the bandit. Figure 5-19 shows an outside view of the F-16 firing a Sidewinder.

Falcon 3.0 Electronic Countermeasures

Electronic Countermeasures (ECM) are techniques that are used to deny the enemy the use of their radar and infrared systems. In Falcon 3.0, these systems are used by the enemy for detection and missile guidance. Falcon ECM systems include the chaff and flare dispenser, and the externally mounted ALQ-131 jamming pod.

The Chaff and Flare Dispenser

Your F-16 is equipped with a dispenser that ejects chaff and flares. A *chaff bundle* consists of small strips of metal that reflect radar energy. These chaff bundles rapidly blossom



HEADING = 356° SPEED = 0351 KNOTS ALTITUDE = 16533 FEET
ZOOM = 01 VIEW = TRACK

Figure 5-19.

Falcon 3.0 air-to-air missile launch

when ejected from the airplane and are effective in decoying radar-guided missiles. *Flares* are pyrotechnic devices that burn when dispensed. This creates infrared energy to decoy IR-guided SAMs.

The appropriate indicators illuminate anytime you dispense chaff or flares, and the counters under the chaff and flare lights count down to show you the amount remaining. You dispense chaff by pressing the DEL key. You dispense one bundle of chaff each time you press the DEL key, and the counter will reflect that you have one fewer bundle. The flare dispenser is identical in operation to the chaff dispenser except that you press the INS key to eject a flare. Falcon 3.0 allows you to select unlimited chaff and flares, or to carry a standard load of 30 chaff bundles and 30 flare cartridges, which should be used *anytime* you are under attack. You do not get any extra style points for dying with chaff and flares on board your jet, so use them when you need them.

The ALQ-131 Jamming Pod

The *ALQ-131 jamming pod* is an external ECM pod used to decoy radar-guided missiles. You choose to load your ECM pod in the F-16 Armament screen by clicking on Other Stores. In Falcon 3.0 you should try to fly with the pod anytime you expect to tangle with enemy SAMs. To turn the pod on, press the E key. When you press this key, the ECM light located under the word *EMIT* will illuminate.

When you press the E key with the ECM light on, you will extinguish the light and turn the pod off. The pod is an effective system for countering enemy radar missiles but it does highlight your position, so turn it on only when you get a "LCK" indication, and turn it off as soon as the "LCK" indication disappears. The tactical use of all ECM systems will be discussed in the next few chapters.

Final Examination

It's time to load up Review 2. This is essentially your Nellis Red Flag final examination, where you'll engage in both air-to-air and air-to-ground combat. Keep in mind that not all aircraft are bandits, so be sure to check your IFF. This is it, from soup to nuts, so you'll be starting off on the runway for takeoff. Take your bird up to 10,000 feet and head for Waypoint 1. Be prepared to engage bandits en route.

Mission Profile

- Three-point strike run

Mission Objectives

- Use a combination of acquired flying skills to take off
- Proceed on flight path
- Engage bogeys and bomb strategic site

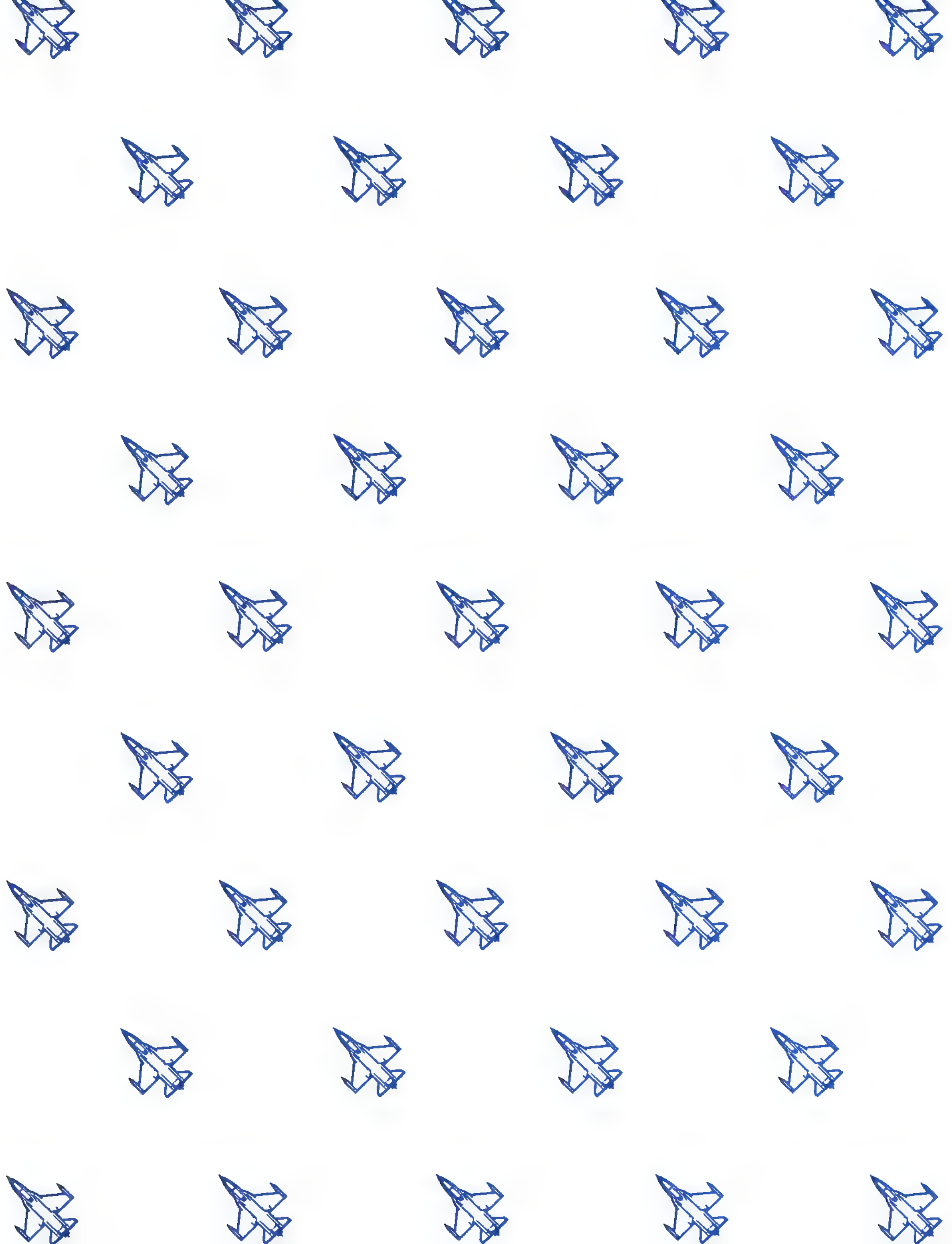
- Return to base and destroy any bandits en route

After you reach Waypoint 1, get ready for Waypoint 2. Waypoint 2 is a bombing mission, so ready your Mk-84s. Your targets are the two towers of a nuclear power plant. Take both towers out and head for Waypoint 3.

After you reach Waypoint 3, turn and head for home. Remember to keep an eye out for bandits. Waypoint 4 is home. Bring your bird in, press ESC, select End Mission, and listen to your debriefing to see how well–or poorly–you did. Practice until you get it right.

Remember: *Combat is no place for mistakes—especially during an extended campaign. Get it right here and you'll increase your chances for survival later.*

Note: *You may run into an F-117 Stealth fighter during your strike. In Falcon 3.0 it shows up on your radar; in real life, it most likely wouldn't.*



CHAPTER

6

THE SPIRIT OF ATTACK

> *"Only the spirit of attack, born in a brave heart, will bring success to a fighter aircraft..."*
>
> –Adolf Galland

The F-16 Fighter Weapons School was a grueling four-month program of intensive flight and academic training on weapons and tactics for F-16 student pilots. Intimidation and general abuse were the standard methods of replicating the stress of combat. The Weapons School sought to produce graduates with a thorough knowledge of advanced fighter concepts, gained through high-intensity "combat" sorties.

Life at the School made me (Pete Bonanni) yearn for the easier alternative of real combat. On this day, we huddled like sheep in the corner of a trailer that was the temporary home of the newly established F-16 Weapons School. We were getting a Basic Fighter Maneuvers (BFM) phase briefing from a particularly nasty individual who went by the call sign of Doofal. He mentioned that if we were going to wash out of the course, it would probably be in the BFM phase. He told us also that in the likely event that we did wash out we would be deemed too dangerous to fly, even as a passenger on an airliner, so the Air Force would issue us a bus ticket back to our home base. I wasn't sure if he was kidding or not, but I didn't relish the idea of riding the "Hound" from Nellis AFB in Las Vegas to MacDill AFB in Tampa. I paid attention to the briefing.

For my first BFM ride, I drew one of the toughest air-to-air instructors at the Weapons School. Skip was a fairly even-tempered guy on the ground but a *mean* son of a gun in the air. A few months prior to our arrival an Israeli F-16 ace had visited the Weapons School and fought Skip one-on-one. Skip had gun-tracked him in all three engagements from offensive, defensive, and head-on starting positions.

The first two BFM rides at the Weapons School placed the student on offense. The mission objective of these rides was to stay behind the instructor and fire a valid missile or gun shot. I managed to do this on the first two engagements but on the third engagement I got spit out. The fight developed quickly into a nose-high flat scissors with both aircraft climbing straight up. (A *scissors* is a maneuver where two aircraft are aligned abreast and are turning back and forth into each other, or scissoring, in order to get the advantage. The pilot who maneuvers the aircraft nose up first will slow forward ground track and get a six o'clock on the opponent.)

As the airspeed plummeted, the controls became less and less effective until Skip and I were staring at each other across a few hundred feet of thin air, and just "riding the Pratt and Whitney blowtorch." When the airspeed fell to double digits the nose of my jet started falling back through the horizon. Skip had somehow managed to hold his nose up a split second longer than I did, and he ended up behind me at close range. The airspeed started to climb when the fight went downhill, and I maneuvered violently as Skip moved into firing position. My jink-out delayed the kill shoot but the fight ended soon after when Skip called a tracking gunshot.

In the mission debrief back at the base, all three engagements were dissected in excruciating detail as Skip pointed out where I had blundered. I figured I'd done OK by staying behind him in two of the three engagements since even the Israeli ace hadn't done as well, but I was wrong. At the end of the debriefing Skip said, "Well, it was a weak ride but I'll pass you anyway. You'll have to do better on the next ride." "Have to do better?" I thought. I had flown the best BFM ride of my life, and I wasn't sure how I was going to improve. As it turned out, I did pass the next ride and somehow made it through the entire course, even though the specter of the bus ticket arose again on a few occasions.

Part of what I learned about F-16 BFM during that course will be covered in this chapter. BFM is the foundation of all air-to-air and air-to-ground missions. You employ BFM every

The greatest number of aircraft to be lost due to air combat and anti-aircraft fire in a single day's battle was on 10 May 1940. The German Luftwaffe had 304 of their planes destroyed and 51 damaged.

time you mix it up with MiGs or roll in to attack ground targets, so you must understand BFM in Falcon 3.0 to understand what is going on.

BFM is divided into three distinct learning blocks: offensive, defensive, and head-on maneuvering. This chapter will focus on the mechanics of maneuvering when you are within visual range of the MiG. To stay behind the bandit in Falcon requires the same skills and knowledge required in the real jet. There is no easy, straightforward BFM technique that applies only to the Falcon 3.0 simulation. Since the simulation is governed by the aerodynamic principles that govern actual air combat, you must learn the same BFM principles that a fighter pilot does.

Energy for Aircraft Position

Basic Fighter Maneuvers (BFM) are nothing more than the exchange of energy for aircraft position. *Energy*, for the purpose of our discussion, is fighter speed and altitude. The goal of *offensive maneuvering* in the simulation (and in the real F-16) is to remain behind an adversary and get in a position to shoot your weapons. In *defensive maneuvering* you must turn your jet so that the bandit is no longer in a position to shoot weapons at you. In *head-on maneuvering* you must get behind the bandit, starting from a neutral position.

When you execute maneuvers to accomplish these objectives you will invariably bleed off or expend energy. Pulling *G*s and turning causes all aircraft to slow down or lose altitude, or both. The following section describes the geometry of the fight and the specific maneuvers needed to be a successful air-to-air Falcon pilot.

BFM Is Flown in the Future

Many discussions of BFM emphasize maneuvers as if they were cards or chess pieces played in a game of moves and countermoves. Modern aerial warfare, however, is actually closer to a wrestling match. It is a fluid contest hinging on the quickness of the opponents' reactions. Hopefully you've learned by now that you are in a dynamic fight with little time for creative thought or slow analysis. Aerial combat requires reaction. As a rule, fighter pilots are not too bright on the ground; in the air, however, they are brilliant for very short periods of time. This period of time is the split second it takes to analyze the situation and react. Because changes occur so rapidly during BFM, you must constantly follow these four basic steps:

1. *Observe* the bandit.
2. *Predict* a future position in space for the bandit, based on your observation.
3. *Maneuver* your jet in response to this prediction.
4. *React* to changes in the situation as you execute your maneuvers.

***Remember:** BFM (Basic Fighter Maneuvers) is flown in the future and not in the present. You must constantly predict the bandit's future position, or where the MiG will be a few seconds from the time you observe it, and fly your jet based on this prediction.*

BFM Geometry

In order to perform BFM the pilot must understand the spatial relationship to the target from four perspectives: positional geometry, attack geometry, the weapons envelope, and the control zone.

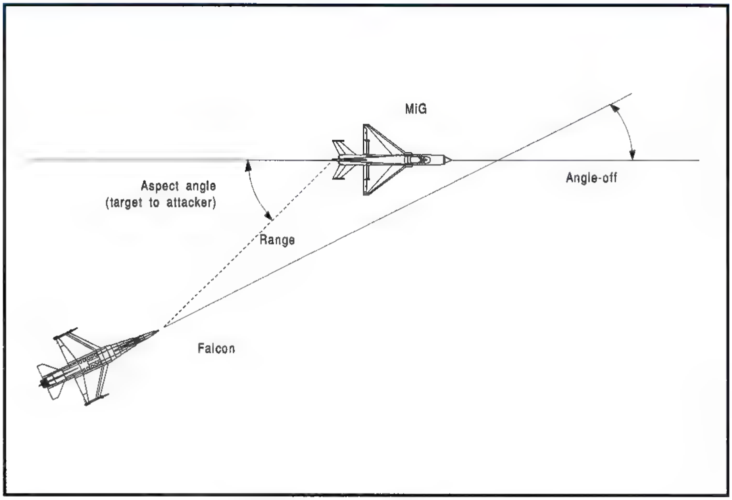
Positional Geometry

Range, aspect angle, and angle-off are the terms used to describe one aircraft's position relative to another. These concepts, depicted in Figure 6-1, define the angular relationship between two aircraft. This angular relationship in turn tells you how much of a position advantage or disadvantage you have.

- *Range* is the distance between your jet and the bandit.

Figure 6-1.

The angular relationship between two aircraft



The German Fokker E series Eindecker, produced in 1915, was the first airplane to have a synchronized machine gun that fired between the propeller blades.

- *Aspect angle* is the number of degrees measured from the tail of the target to your aircraft. Aspect angle is important because it tells you how far away you are in degrees from the stern of the target (the desired position).
- *Angle-off* is the difference, measured in degrees, between your heading and the bandit's heading. This angle tells you relative fuselage alignment. For example, if the angle-off were 0 degrees you would be on a parallel heading with the bandit and your two fuselages would be aligned. If the angle-off were 90 degrees, your fuselage would be perpendicular to that of the bandit.

Attack Geometry

Attack geometry describes the path that the offensive fighter takes when converging on the bandit. When you start an attack there are three distinct paths or pursuit courses that you can follow: pure pursuit, lag pursuit, or lead pursuit. If you are pointing directly at the bandit you are flying a *pure pursuit* course. If you are pointing behind the bandit you are in *lag pursuit*, and if your nose is out in front of the bandit you are in *lead pursuit*. Figure 6-2 shows these different pursuit options available when attacking the bandit.

You can tell what pursuit course you are flying by the position of the Flight Path Marker in relation to the MiG. Figure 6-3 shows a lead pursuit course. Notice the Flight Path Marker out in front of the bandit. If you were in pure pursuit, the Flight Path Marker would be right over the bandit. If you were in lag pursuit the Flight Path Marker would be behind the bandit.

The Weapons Envelope

The weapons envelope is the area surrounding the bandit in which you are in parameters to shoot a missile or the gun. The parameters are defined by range, aspect angle, and angle-off. The dimensions and position of this area are dictated by the type of weapons that you are carrying. If your jet is loaded with all-aspect AIM-9Ms, the envelope looks like a doughnut, with the inside circle being minimum range (Rmin) and the outside circle being maximum range (Rmax). Figure 6-4 shows a shaded doughnut area that represents the AIM-9M weapons envelope. If you are carrying an AIM-9P stern, or rear-aspect missile, the vulnerable area is cone-shaped, as shown in Figure 6-5.

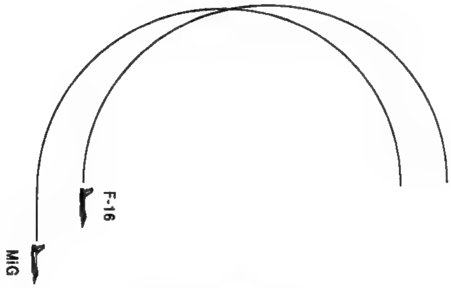
These two missile envelopes are so different because the seeker heads of the missiles work differently. The *P* model Sidewinder seeker head can only pick up IR energy from the target's engine from the stern or rear of the target. The *M* model's seeker head can sense IR energy from the target from all aspects (360 degrees).

The Control Zone

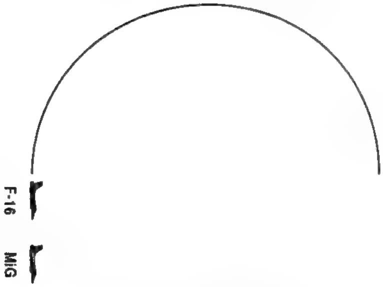
The control zone, also called *the elbow*, is the area behind the bandit where you can establish a stable position in which to employ your weapons. From this position it is relatively easy to remain behind the bandit and in control.

Figure 6-2.

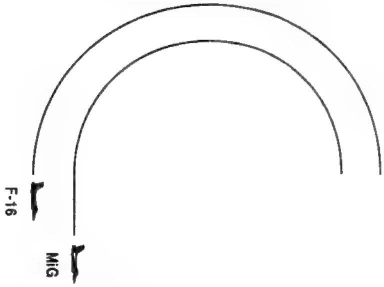
Pursuit options



F-16 in lead pursuit



F-16 in pure pursuit



F-16 in lag pursuit

Figure 6-3.

A cockpit view of a lead pursuit

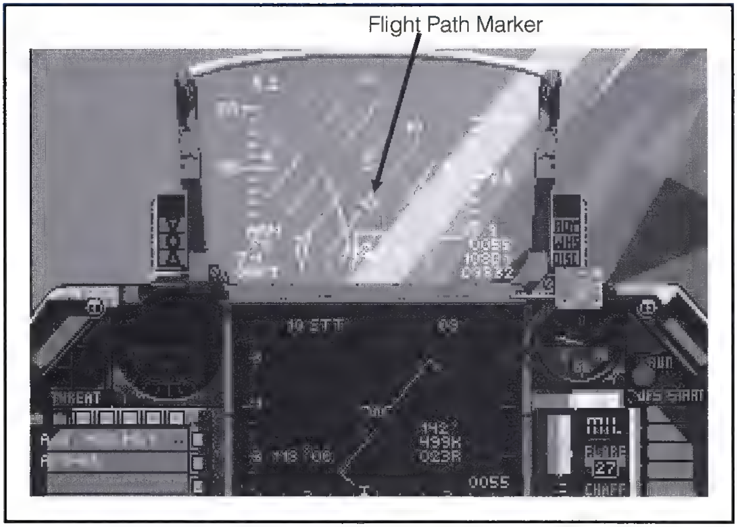


Figure 6-4.

The AIM-9M weapons envelope

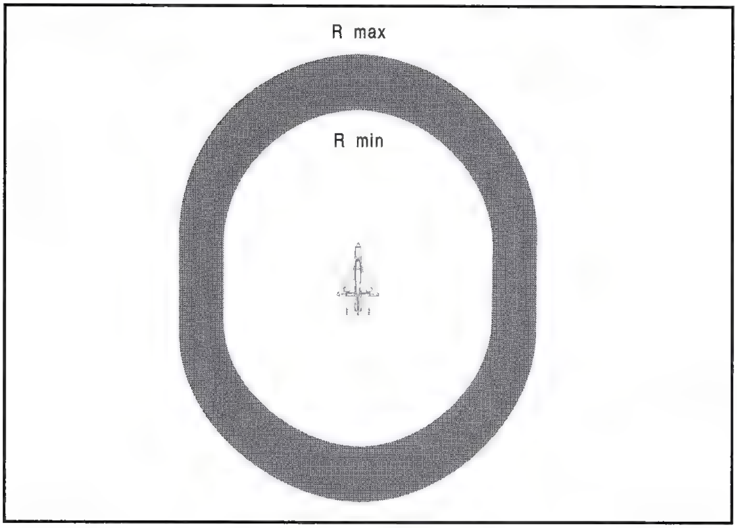
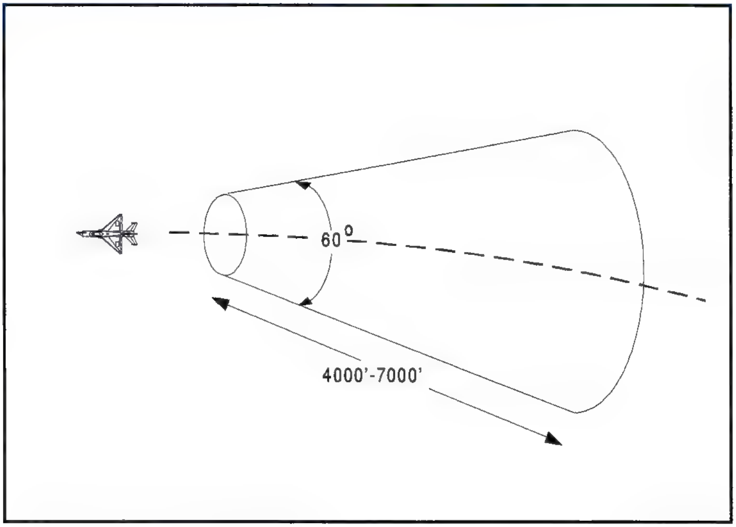


Figure 6-5.

The AIM-9P weapons envelope



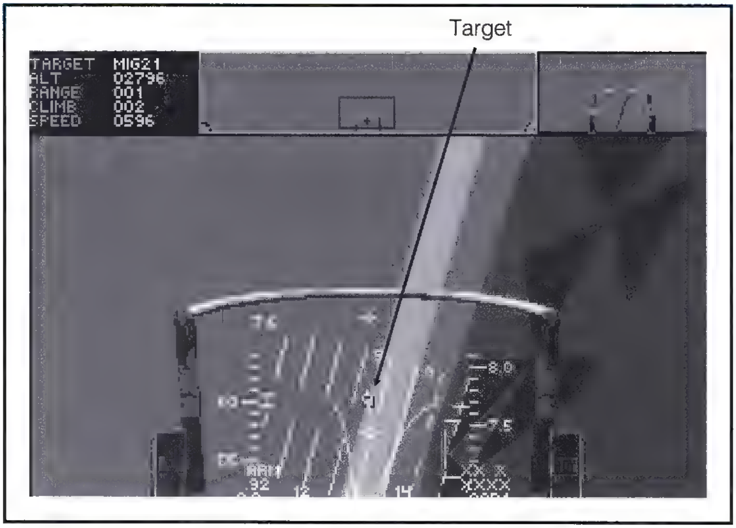
Note: *The control zone is called the elbow because when fighter pilots describe air combat with their hands, the elbow of the arm that is showing the bandit's motion is the approximate position of the control zone.*

In Falcon 3.0, this position is about 3,000 to 4,000 feet behind the maneuvering bandit when the bandit is at corner velocity. *Corner velocity* is the speed at which an aircraft can turn the fastest, tightest turn. As the bandit bleeds off energy and slows down, the control position moves closer to the bandit. A bandit at 200 knots, for example, has a control position of 1,500 to 2,000 feet. This is because a bandit cannot generate a very high turn rate at this slow speed, so you can fly much closer to the bandit and still stay in control.

BFM is flown so you arrive at the elbow of the bandit with 100 knots of overtaking airspeed (overtake), and within 30 degrees of the bandit's heading (angle-off). Figure 6-6 shows the view from the cockpit when the Falcon is in the control position on a bandit. Note that this position also places you in the weapons envelope for your AIM-9P.

Figure 6-6.

The F-16A HUD in guns mode in the control position



TARGET MIG21
ALT 02796
RANGE 001
CLIMB 002
SPEED 0596

The Logistics of BFM

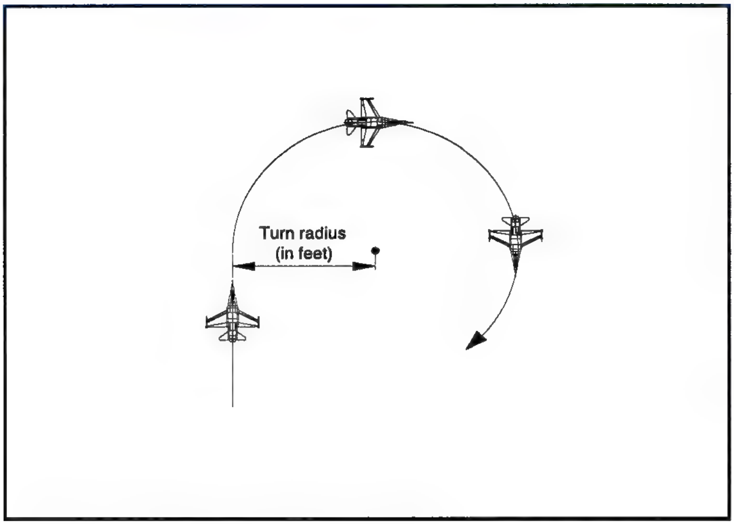
You will recall that aircraft maneuvers consist of three main actions: rolling, turning, and accelerating. Roll is used to position your lift vector. The nose of the aircraft will turn in the direction of the lift vector once you put some *G*s on the jet. Offensive BFM involves turning your jet to solve aspect, angle-off, and overtake problems created by the bandit's turns. Unfortunately, this is no easy task. You must know precisely where and how to turn in order to successfully solve these problems and remain behind the bandit. The next section discusses the characteristics of a turning jet.

Turn Rate and Radius

Two characteristics of a turning aircraft that a fighter pilot must understand are turn radius and turn rate. *Turn radius* is simply a measure of how tightly your jet is turning. If you were looking down on the aircraft as it turned, turn radius

Figure 6-7.

The Aircraft turn circle



would be the distance from the center of your *turn circle* to the aircraft, measured in feet. Figure 6-7 shows this circle.

The equation for turn radius is

$$TR\ (\text{turn radius}) = V^2/gG$$

V is the aircraft's velocity in feet per second. g is gravity and G is the *G*s the aircraft is pulling.

The North American P-51 Mustang was one of the most famous Allied fighting planes of WWII. More than 15,000 Mustangs were built.

It is not important that you understand how to compute turn radius, but it is important that you realize that velocity is squared in the turn radius equation. This means that the fighter pilot must control velocity (airspeed) to control the turn radius. The equation also includes aircraft *G*s. The more *G*s that you pull, the tighter the turn.

Turn rate is the second important characteristic of turning the jet. Turn rate is how fast the aircraft is moving around the turn circle we just talked about, or how fast an aircraft can move its nose. Turn rate is measured in degrees per second and is also dependent on *G*s and airspeed.

Turn rate = K G/V

K is a constant and G and V are again, respectively, *G*s and velocity. This equation tells the fighter pilot that the highest *G*s possible, at the lowest airspeed, gives the best turn rate. Turn rate is very important in BFM because it is a measure of how fast you can put your nose on the bandit. Since you have to put your nose on the bandit to shoot at it, you obviously require a fast turn rate.

***Remember:** The higher the Gs, the faster the turn.*

Controlling Airspeed

You will never master Falcon 3.0 BFM unless you can control your airspeed. A good overall combat airspeed is 400 to 450 knots. If you fly faster than this when you are trying to turn, the result will be a very large turn radius and a slow turn rate. Flying faster than 450 is not a good idea in a turning fight. If you fly slower than 400 knots, your turn radius will be small but your turn rate will decrease because you will be unable to achieve high *G*s at a slow speed.

To achieve the proper airspeed in an air-to-air configuration, set the RPM at about 80 percent to 90 percent. Remember that this is the airspeed you are striving for once you start a sustained turning engagement with MiGs. In an air-to-ground configuration (with bombs or Mavericks loaded), or in the presence of SAMs, you will want to keep your speed up to at least 550 knots. If you start turning with a bandit while loaded with bombs, you will soon bleed down your airspeed to the desired fighting speed of 400 to 450 knots.

***Note:** The best way to accelerate in Falcon 3.0 is to convert altitude into airspeed. The best way to do this, provided sufficient altitude, is to light the afterburner (AB), roll inverted wings level with the horizon, pull back on the stick until you're in about a 30° dive, and then once you reach your desired speed, roll level, and pull out. This accomplishes an increase in airspeed without pulling negative Gs.*

Acceleration

Acceleration is how fast you go faster. This is very important because BFM usually results in energy bleed off, and a fighter must be able to regain this energy by acceleration.

Falcon 3.0 Offensive BFM

Now that you have covered the geometry of the fight and some basic mechanics, you will learn about specific offensive, defensive, and head-on F-16 maneuvers. In an air-to-air fight you are forced to execute specific maneuvers in response to the bandit's. In offensive maneuvering, BFM must be performed whenever the bandit turns into you and creates aspect, angle-off, and range problems.

All simulations have restrictions and Falcon is no exception, though the Padlock View compensates for some of these limitations. The MiGs in the simulation are difficult to see until they are at very close range. Outside of 3,000 feet, it is very difficult to tell what the bandit is doing and to judge the geometry of the fight. Because of this, most fights with the bandit result in a confusing "fur ball" of high-speed passes and missile engagements at ranges greater than one mile. You know you did good when the bandit blows up, but you're not sure what happened or why.

In this section you will learn methods for going through the basic BFM steps of observing, predicting, maneuvering, and reacting. You will also learn some simulation "work arounds" that will help you execute the offensive BFM needed to win the fight.

Note: *The BFM that you can actually execute in Falcon 3.0 is constrained due to the tunnel vision of flying on a computer. Padlock and track views help to reduce this constraint.*

Setting Up the Fight

For this training mission, enter Red Flag from the War Room and select Clear Mission. This will place you in the default scenario with you versus one MiG-29. Select F-16 Pilots, designate your particular pilot, and then select Load Armament. Load up with some AIM-9Ps to practice rear-aspect shots.

Mission Profile

* Engage MiG-29

Mission Objectives

* Practice Offensive BFM and attempt to stay on bandit's six

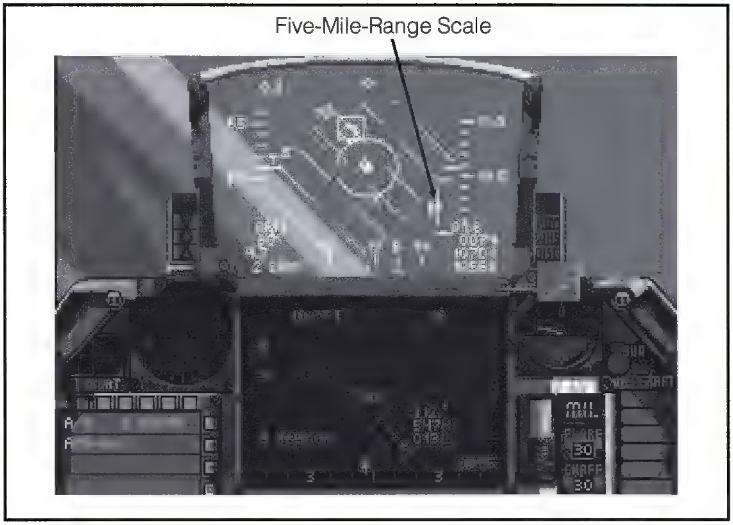
* Destroy target using rear-aspect AIM-9P air-to-air missiles

After selecting Takeoff, you will find yourself at altitude in the cockpit. Pull the power back to 80 percent to establish your airspeed at 400 to 450 knots and watch for the bandit in your REO display. If you only use your radar to get an idea of where the bandit is, you should be able to visually lock on and sneak up on the MiG. Otherwise, if you maintain radar contact, you will show up on the MiG's Radar Warning Receiver and the bandit will act accordingly.

Once you are established at the MiG's six o'clock, select the Sidewinder missile mode and note the position of the aspect caret in the HUD. Figure 6-8 shows the Falcon established behind the MiG. As you fly the jet, adjust the throttle to match the MiG's speed as closely as you can. Note when the MiG turns, as you must turn in response to this movement. That is essentially the solution to the BFM problem of a

Figure 6-8.

The Falcon established behind a MiG. Notice the Five-Mile-Range Scale shows the target at approximately two miles from your jet


Five-Mile-Range Scale

turning bandit in Falcon 3.0. When the bandit turns, you turn. The following steps will cover when and how you turn the Falcon to stay behind the MiG:

1. Use the HUD, the radar scope, and the Threat Warning Indicator to *observe* the MiG. If you cannot determine the bandit's direction of turn by looking out of the HUD and seeing the MiG, then look at your Threat Warning Indicator. There you'll see the MiG moving around the circle, either clockwise or counterclockwise. (Note that you will only see the MiG if it is emitting radar signals.)

   The Waypoint Caret moves along the Heading scale either along the top or bottom of the HUD, depending upon what is taking place. If you are a rookie, the C HUD is more forgiving. Airspeed, altitude, and heading are displayed in stationary boxes, the Five-Mile-Range Scale has been left out and the word "SHOOT" will flash when weapon employment parameters have been achieved.

   Navigating to waypoints in the F-16C HUD is more simplified than in the F-16A HUD. The Heading will be framed by steering cues < and >, which will direct you either left or right depending on your flight path. The heading will be framed between both < and > when you are flying to your waypoint.

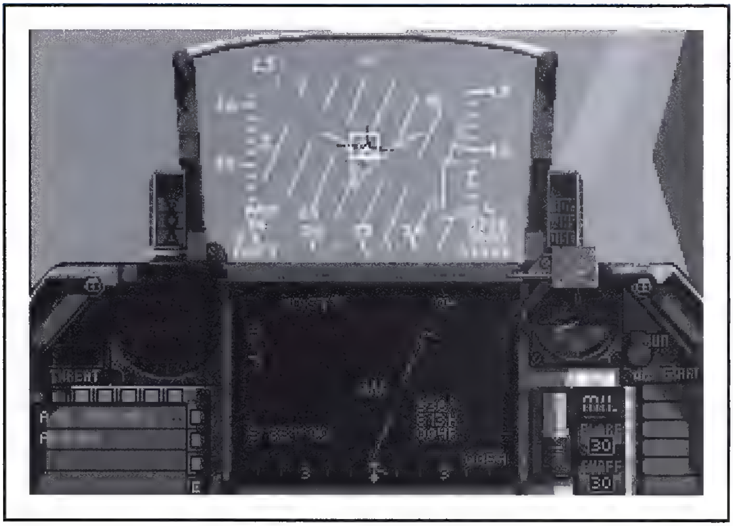
2. When you observe the direction of turn for the MiG, *predict* its movement across the sky and start a turn in the same direction. For example, if the MiG moves to the left in your HUD or on your Threat Warning Indicator, you turn left.

3. As the MiG starts turning out in front of you, *maneuver* to place the Flight Path Marker out in front of the MiG (lead pursuit) and start pulling from 5*G*s to 7*G*s. Adjust the airspeed to gain 50 knots of closure (read closure in the bottom-right corner of your radar scope). Figure 6-9 shows this position on the MiG.

Note: *In Falcon 3.0, you can display either the F-16A HUD, or the F-16C HUD. The F-16A HUD has vertical scales for airspeed, altitude, and a Five-Mile-Range Scale when in A-A missile mode. This scale uses a caret that moves up and down along a vertical scale indicating a bandit's range from five to one miles out. The caret is not displayed unless a bandit is within five miles.*

Figure 6-9.

Getting into a tracking position, Guns HUD



4. You must now observe the movement of the MiG in your HUD to determine how you will *react.* The MiG will do one of three things in relation to your Flight Path Marker:

   - If the MiG stays in the same spot in the HUD, you are matching the MiG's turn rate and will close the range and fly to the elbow. Just keep doing what you're doing and prepare to strike a blow for freedom. If you are armed with Sidewinder missiles, shoot. If you are "Winchester" (have run out of missiles), switch to guns and fire when you can discern the wings of the MiG. Figure 6-10 shows this gun-firing position on the MiG.

   - If you pull the Flight Path Marker to lead pursuit and the MiG moves rapidly across your HUD and back under your nose, ease off the *G*s and let the bandit fly back into view. In this case you are pulling

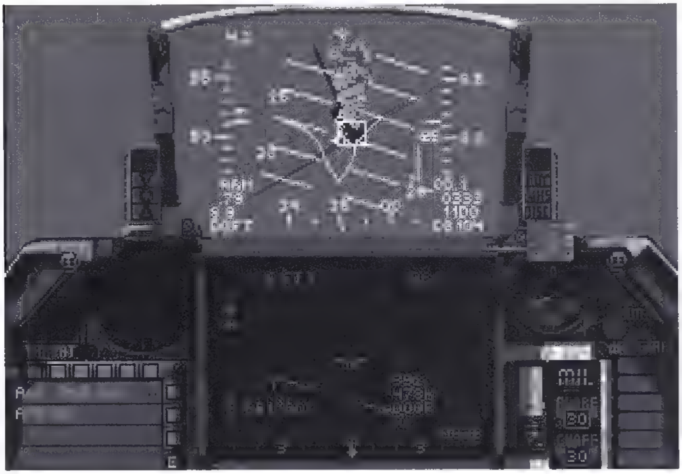


Figure 6-10.

A MiG-29 taking hits from your 20-mm cannon

too much lead for the MiG's present turn rate. Once you regain a tally ho (visual sighting), put the Flight Path Marker behind the bandit in lag pursuit. Figure 6-11 shows a lag pursuit position on the MiG. In this figure, you are pointing behind the MiG, and when the range closes, the MiG will start moving away from you in the direction of the turn. When this occurs, pull your nose back to lead pursuit and again get ready for a gunshot. In both of these cases you may pass through Sidewinder parameters and be able to fire.

* If the MiG moves through the Flight Path Marker and you go from lead to lag pursuit, you are not matching the MiG's turn rate and will overshoot. An *overshoot* is when you fly past the MiG and are in danger of going out in front of him. Figure 6-12

Figure 6-11.

Lag pursuit. Notice the position of the Flight Path Marker

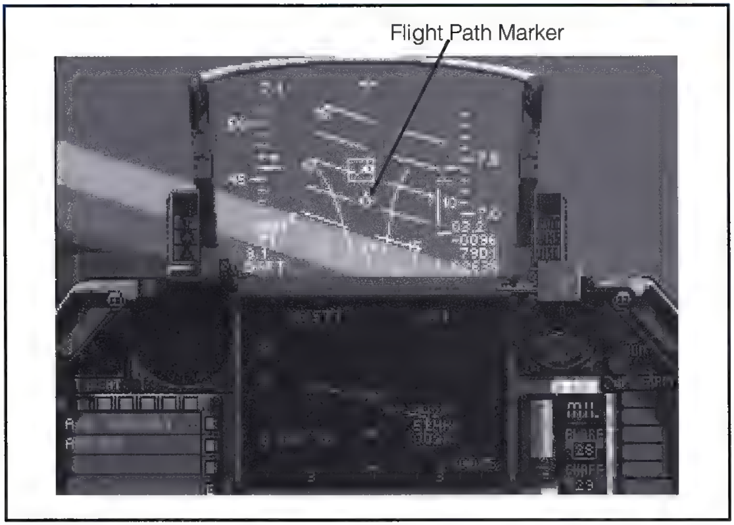
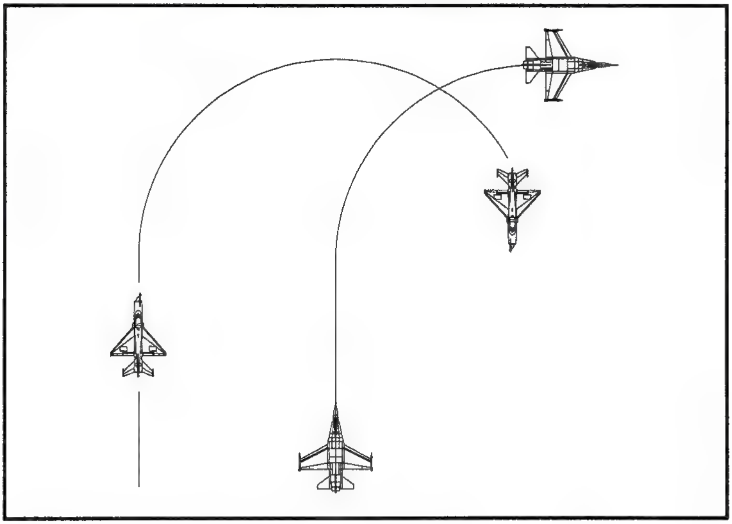


Figure 6-12.

A bird's-eye view of an overshoot



shows a bird's-eye view of an overshoot situation. The solution to this problem is to turn the Falcon as hard as possible and check your airspeed. If you are over 450 knots, you will overshoot the MiG every time. (Remember velocity is squared in the rate and radius equations.) If you do overshoot in Falcon, don't worry; just keep turning in the direction of the MiG and you will get behind him.

All of these steps are designed to get you to the elbow of a bandit. You must be aware of your airspeed and closure at all times when flying these maneuvers. The next section will cover what to do once you've cleverly trapped a bogey at *your* six o'clock.

Falcon 3.0 Defensive BFM

You are not sure what went wrong but the MiG is on your tail, a bloodthirsty bandit at your six o'clock. Before you reach for the ejection handle (SHIFT-E), let's discuss your options in Falcon 3.0. Defensive BFM is a very easy concept to grasp in Falcon 3.0 (and in the F-16). A will to survive is a pilot's most essential characteristic. The geometry of the defensive fight is very simple and the maneuvers are equally straightforward. You must be able to execute them, however, while you are under both mental pressure and the physical duress of violent high-*G* maneuvering. Defensive maneuvering requires patience, stamina, and optimism. Keep asking yourself, "Self, am I still alive?" If the answer is yes, keep fighting.

Maneuver and ECM

The first thing you need to do on defense is create BFM problems for the bandit. From our previous discussion, you know how difficult it is to stay behind a hard-turning bandit. In order to give the enemy the same trouble you experienced, execute the following procedures for the defensive situations given in the next sections.

Missile Launch

Pay close attention to the Threat Warning Indicator. If you see or hear a missile launch indication at any time during the simulation, stop what you are doing, and take these steps:

1. Dispense chaff and flares and turn on your jamming pod (the ALQ-131) if you have one.
    - To dispense chaff, press the DEL key.
    - To dispense flares, press the INS key.
    - To turn on the jamming pod, press the E key.

      Don't try to interpret which type of missile the enemy is firing; you will have plenty of time to ponder that in the POW camp if your defensive reactions don't work.
2. While you are using your ECM, you must also put maximum *Gs* on the jet as rapidly as possible to give the enemy missile a difficult target. Again, don't sweat which way to turn, just do it. A missile launch requires you to move quickly.

   If you get a lock-on indication, that is your Threat Warning Indicator flashing LCK, before you get a launch, dispense chaff only and turn the pod on. In this case you have more time to maneuver the jet against the MiG.

Bandit at Six O'clock

If a MiG is at your six o'clock and you get a lock-on indication or no indication, look at the Threat Warning Indicator to figure out the direction of your defensive turn and execute the following steps:

1. If the MiG is on the right side of scope, turn right. If it is on the left, turn left. In the rare instance that you can actually see the bandit, turn towards the bandit.
2. Roll to set your wings at approximately 80 to 90 degrees of bank and start a hard turn into the bandit at *maximum*

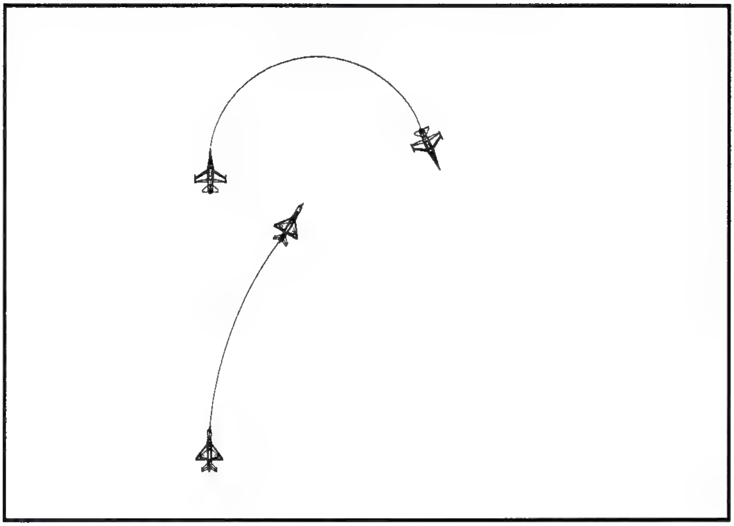
G; in other words, turn with as much *G* as the jet will give you.

3. Next, look at the Threat Warning Indicator, note the direction of movement of the bandit on the scope, and react accordingly:

   * If the bandit is moving toward your twelve o'clock position, your turn is working. You are giving the bandit an unsolvable problem—the MiG is being forced out in front of you. Keep turning until the bandit gets to your nose and your radar locks on. At this point you are no longer on the defensive but are now probably flying offensive or head-on BFM. Figure 6-13 shows a bird's-eye view of a successful defensive turn.

Figure 6-13.

A bird's-eye view of a successful defensive turn



* If you turn hard into the bandit but can't maneuver the MiG to the twelve o'clock position on the Threat Warning Indicator, you are in for a real tussle. The first thing to do is to check your airspeed. This is always a good thing to do in any air-to-air situation when things aren't going well. If you are flying faster than 450 knots, slow down to give your jet a tighter turn circle. If you are flying slower than 350 knots and you are not in AB, get there by pressing the / key and then the > key, which should get your airspeed up to 450; if it doesn't and you still have external stores on the jet, jettison them by pressing CTRL-K. This will clean off the entire aircraft by dropping everything that you have hanging on the wings. You can also jettison *centerline* stores (stores not carried on the wing) by pressing CTRL-C.

Hopefully, one of these steps solved your problem and the bandit is now moving forward toward the twelve o'clock position on the Threat Warning Indicator. If not, there is nothing more that you can do but keep turning and hope the bandit makes a mistake or the MiG runs out of gas. Unfortunately, there is no magic move that would put the bandit out in front of you. The important thing to remember is that a MiG at six o'clock is better than no MiG at all to a confident and aggressive fighter pilot.

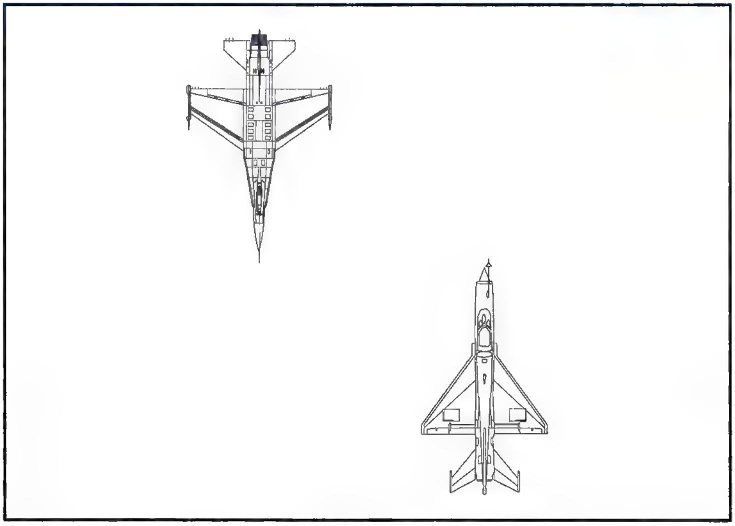
Falcon 3.0 Head-on BFM

This BFM is flown after passing the bandit head-on. You have the option at this point to separate from the bandit. You also have the option to turn and duke it out. If your mission is to kill the bandit, you have to know how to fight head-on BFM. Falcon 3.0 head-on BFM is very easy to execute but difficult to understand. The following steps will help you take a head-on situation and convert it into an offensive one:

1. Use the Threat Warning Indicator, the HUD, and the radar scope to point at the bandit (or place the MiG at your twelve o'clock position).
2. When you get a missile lock indication in the HUD, and the bandit is still BVR (Beyond Visual Range), shoot an AMRAAM. If the bandit is WVR (Within Visual Range), go for a shot with the AIM-9 Mike. If that shot doesn't work, switch to guns and shoot when you get inside one mile. If you are using the F-16A HUD, this can be determined by watching the Five-Mile-Range Scale.
3. Stay heads up for a missile launch indication on your Threat Warning Indicator as the bandit approaches. Execute the steps discussed in the defensive BFM section if you do get a launch indication. There should be no doubt in your mind; when somebody shoots at you, you're defensive.
4. When you see the bandit fly past you, or when you see the bandit on the Threat Warning Indicator move toward your six o'clock, start a hard turn at 5*G*s to 7*G*s in the direction of the bandit. Figure 6-14 shows a bird's-eye view of a head-on pass with the bandit. It is not important which way you turn at the pass; it is only important that you initiate the turn quickly after passing the bandit.
5. After starting a hard turn into the bandit, keep the turn coming until you get the bandit in your HUD again. Analyze the aspect and if it is high (above 120 degrees), you are still in a head-on fight. Go back to step one. If the aspect angle is medium or low, you are winning the contest of head-on BFM. Just keep pulling hard in the bandit's direction and you will soon be behind it.
6. Anytime you get very confused, remember this: always turn in the direction of the bandit. If you can't think of anything else to do, just keep turning into the MiG, using the Threat Warning Indicator as a reference.

Figure 6-14.

A bird's-eye view of a head-on pass



You have covered maneuvering from offensive, defensive, and head-on situations. The goal of all this is to survive the attack of the bandit and shoot down the MiG. To do this you need weapons. The next section will cover Falcon air-to-air weapons employment.

Weapons Employment

This section looks at how to set up and use the variety of weapons that Falcon 3.0 gives you.

Sidewinders

The *Sidewinder*, or *AIM-9 (Air Intercept Missile)* in Falcon is an easy weapon to use. Both the *M* and the *P* missiles will be discussed together even though they perform differently. You have already learned about Sidewinder symbology in the HUD and seen charts for the Sidewinder missile envelopes earlier in this chapter. This section looks at the tactical use of the missile in the Falcon simulation.

If you are on an air-to-ground sortie, you only need to call up your bombs or Maverick missiles just prior to employing them. After attacking a ground target, re-select the Sidewinder mode. With the Sidewinder selected you will get the Aiming Reticle with aspect caret presented in the HUD and you will be able to fire at the bandit as soon as you get a missile lock. To fire the Sidewinder, follow these steps:

1. Select the missile.
2. Fly the target into the HUD. (The target does not need to be in the Missile Reticle, but it helps.)
3. Keep the target in the HUD; if you have selected the all-aspect AIM-9M, the seeker head diamond will bounce around the HUD. The Sidewinder will emit a low humming sound while it seeks lock. Wait for the flashing diamond and flashing Aiming Reticle and a higher pitched whining sound or squawk.
4. Note the target line of sight (LOS) rate. The line of sight rate is the speed at which the target is moving across your HUD. If the target moves out of your HUD in the time it takes the missile to get there, the LOS may be too high for a good shot. The Sidewinder missile in Falcon 3.0 usually takes about four to seven seconds to reach the target. If you can't keep the target in your HUD for that long, you will probably waste a missile if you shoot.
5. Shoot as soon as the above conditions are met!

***Note:** You should always fly with the AIM-9M (or AIM-9 "Mike") Sidewinder missile selected if you have one loaded. If you don't have an M-model Sidewinder, fly with the AIM-9P (or AIM-9 "Papa") missile selected.*

The *P*, or Papa, model Sidewinder is a "back shooting" or a rear-aspect weapon, that is, it can only target the rear quarter of an aircraft. It is best to get behind the bandit before firing. (This is referred to as a "Papa shot" due to the parameters required for weapons employment.) The *M*, or Mike, model will let you shoot from all target aspects and is generally better against a hard-maneuvering target.

The AIM-120 AMRAAM

The AIM-120 is an Advanced Medium Range Air-to-Air Missile that is a pleasure to use. It has a range of 30 miles, a larger Aiming Reticle, and is aimed much as the all-aspect AIM-9M. AIM-120 firing parameters are closer to all-aspect 9-Mike rather than the Papa. BVR head-on intercepts are possible with the AIM-120.

The AIM-120 with its active radar homing can be fired from any aspect angle. It is also capable of acquiring a target BVR (Beyond Visual Range). Keep your target in the Aiming Reticle; when your AIM-120 locks, the seeker head diamond will drift over to the TD Box and the Aiming Reticle will flash. If you are using the F-16C HUD, the word "SHOOT" will flash, alternating with the flash of the Aiming Reticle.

The Vulcan M61A1 Cannon

The M61A1 cannon is a staple of air-to-air combat. The gun is used when the stress factor is up and the chips are down. The gun is a weapon that can be fired when you are in tight on the bandit and inside missile parameters. If the LOS rate is high (as defined in the previous section) you should switch to guns. The following steps will help you kill the MiG with the gun:

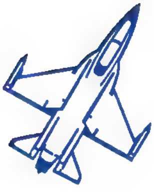
1. Select the gun.
2. Observe the movement of the M61 Aiming Funnel when you are tracking a bandit prior to firing. The Aiming Funnel length will increase or decrease in relation to how many *G*s are being pulled. The bullets will hit a target at the bottom of the Aiming Funnel.
3. Prior to the bandit reaching the bottom of the Aiming Funnel, open fire. Remember that the gun shoots unguided projectiles with a specific time of flight. Because of this, you must hold the target steady at the bottom of the Aiming Funnel for the length of time the bullet is in flight, or you must open fire early and keep firing until you get the bottom of the Aiming Funnel over the target.

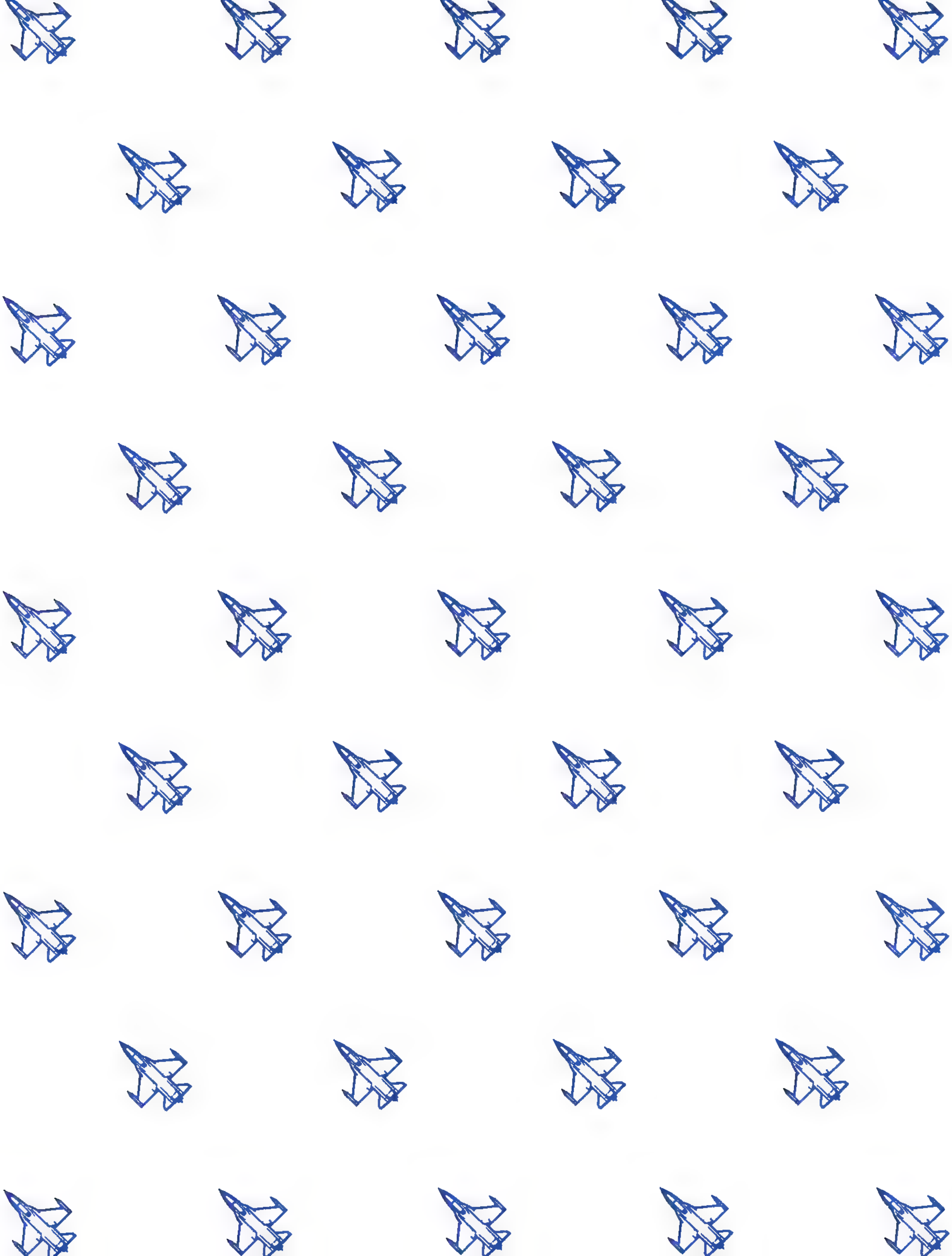
***Remember:** When the bandit is in range in your HUD, draw your gun.*

4. Since you have a very large load of 20-mm cannon shells in your Falcon, shoot whenever the MiG gets close to your HUD.

Why Fighter Pilots Were Born

Flying BFM in the F-16 is a wonderful thing. The F-16 is a small, highly maneuverable fighter that can dominate most other jets in a maneuvering fight. You must be aware, however, that maneuvering at high *G*s to get to the bandit's six o'clock is not the objective of the fight. Fighter pilots were born for one thing: to kill the enemy and survive the engagement. To kill the enemy you must use your weapons. The best air-to-air engagements are brutal ambushes of the enemy. One minute the bandit is flying along nice and relaxed, the next minute your missile hits and body parts are flying formation with pieces of jet. Entering a sustained maneuvering fight can be very unhealthy in modern aerial combat. As you go around and around with the bandit, other pilots are attracted to the fight like moths to a flame. You may be winning the fight that you're aware of, while you're losing a fight that you don't know you're in. For this reason you should shoot every time you get within parameters on the enemy and end the fight quickly. The life you save will be your own.





CHAPTER

7

AIR-TO-GROUND COMBAT

"You can shoot down every MiG in the sky, but if the tank commander of the lead Soviet tank is eating lunch in your squadron when you land, you've lost the war."

-anonymous fighter pilot

It was the first Operational Readiness Inspection (ORI) for an overseas F-16 Wing, and the "Wolf Pack" (the Eighth Tactical Fighter Wing) was tasked by the inspection team to mobilize for "war." An ORI is a fun-filled affair that usually lasts about one week and features all of the thrills and excitement of real war, including wearing full anti-chemical gear, flak vests, and steel helmets. You haven't experienced fun until you've tried to brief a complex mission while wearing a gas mask to a room full of pilots also wearing gas masks. Nobody can understand what you are saying; you shout, grunt, and hope for the best.

During an ORI you experience constant enemy attacks carried out by "sappers" and "enemy aircraft" that make you stop what you're doing, don all that stylish war apparel, and run for cover. Fighter pilots are issued .38 caliber pistols without bullets. In a real war they would presumably give you bullets–*not* that that would do any good against a very skilled and suicidal enemy soldier with an assault rifle.

In addition to the misery of life in and around the squadron during an ORI, you fly realistic "combat missions" that test the Wing's ability to carry out its wartime tasking. The Eighth Tactical Fighter Wing is stationed at Kunsan Air Base in the Republic of Korea, and has the primary mission of attacking the enemy in depth, disrupting and destroying their forces in the air and on the ground. The Wing flies at a grueling pace during one of these inspections, which tests the stamina of both the pilots and the maintenance personnel. After experiencing an ORI as a young fighter pilot one quickly realizes that the fun has gone out of war fighting.

This was my (Pete Bonanni's) second ORI. I had participated in my first at Clark Air Base in the Philippines while flying the F-4. In the Philippines I was a brand-new Lieutenant when the inspection hit the base. All I had to do was stay close to my leader and not do anything stupid. In the second ORI, I was a new Captain and a flight lead with about 600 total fighter hours, 500 in the F-4 and 100 in the F-16. At this stage in a fighter pilot's career it's normal to have a somewhat distorted view of yourself and your abilities. I felt omniscient and invulnerable and couldn't wait to take on the entire Soviet Air Force. The humbling experience of the USAF Fighter Weapons School was still in my future. Of course in reality I was no Steve Canyon, and the first mission of the first overseas F-16 ORI proved it.

The afternoon the ORI inspectors showed up on the base, they handed us the Air Tasking Orders (ATO), which listed the missions we were going to fly the next day. The first mission of the "war" was a 12-aircraft raid on the island of Torishima off the coast of Okinawa, 500 miles to the south of Kunsan Air Base. The Wing Commander tasked our squadron to lead the raid, and my Squadron Operations Officer came and asked me if I could hack it. As he explained the mission to me, the words of a fighter pilot song came to mind: "I told him I would go, because they haven't found / A target in hell, that I couldn't pound." I answered, "This mission is no hill for a climber, sir. I thought for a minute there that you had something challenging for me." With those words the planning for the great raid on Torishima got under way.

It was after 8:00 P.M. by the time the ATO got sorted out. I started the detailed planning for the attack. The jets were armed with live Mk-84 2000lb bombs, and we had a prestrike and poststrike air refueling scheduled. After getting our prestrike fuel top-off, we were tasked to fly a 120-mile low-level that brought us to the target island. The island itself was just a rock out in the middle of the East China Sea with some vehicle hulks scattered around on it. I planned a low-level ingress and a fly-up to medium altitude with the four ships in trail formation. (*Ingressing* is a fighter pilot term that refers to entering enemy territory.) The threat was briefed as MiGs (played by F-15s), small-arms fire, and AAA (Anti-Aircraft Artillery) in the target area. All 12 pilots helped plan the mission, and by midnight we were ready for the 4:30 A.M. briefing. I stayed up until about 2:00 A.M. to double-check all of the numbers and make sure I had things straight in my head. The importance of the mission was underscored the next morning by the presence of the Wing Commander in the flight briefing. After the briefing we walked to our jets, and then took off into a clear and cold spring morning for what was supposed to be a three-hour mission.

The Mikoyan-Gurevich MiG-15, built by the Soviets in 1948, weighed 8311lbs empty and up to 14242lbs with a full load. Its top cruising speed was 652 mph at a maximum altitude of 49,210 feet. Its range was 560 miles.

We hit the tanker as scheduled, dropped off, and headed for the low-level start point. Everything looked fine as we descended to low altitude and started our run for the target. After about 60 miles we started to pick up a few clouds and had to fly lower to get under them. As we flew along, the clouds got thicker and the ceiling got lower. I switched to Ground Map Radar mode to examine the clouds, and discovered they were thunderstorms, very thick and dangerous. We were getting deeper and deeper into the storm at a low altitude, and I had to make a decision. I decided to weather-abort the mission. The 12-ship formation was strung out for about 20 miles on the low-level, so I figured each 4-ship formation would turn around and return to the tanker track to get gas, and then we would reassess the situation.

As we began to turn around, my number four man had an electrical problem. Electrical problems in the F-16 can be serious, so I had my number three man escort him to the nearest airfield, which was Kadena Air Base in Okinawa, less than 150 miles to the southeast. They left the formation as we climbed to medium altitude. We were down to just me and the ORI inspector in my formation as we headed back to the tanker. I expected to see eight F-16s at the tanker track but there were only four of them. I asked the flight lead of the four-ship where the other jets had gone and he said the others had enough gas to make it all the way back to Kunsan and didn't need to air refuel.

Now we were down to six jets from our original 12, and we still had our bombs loaded. So far this flight was definitely not one to write home about. As I was getting gas from the tanker I thought of a plan to try to hit the target with what was left of the strike package. Since we were fewer in number the tanker had more gas to give each aircraft. I asked the tanker to call his command post to see if he could stay in the refueling track another two hours so we could try another approach to the target. The tanker pilot made the call and said he would stay as long as we needed him. After all six jets got their fuel, I briefed a new plan. This time instead of flying the low-level we would try to fly around the storm line at medium altitude, keeping a close eye on our fuel.

Back at the "war" at Kunsan, the Wing Commander was informed that two aircraft with live bombs had just landed at Kadena AB. Shortly after he was told that a flight of four F-16s from the Torishima raid had just landed with *their* bombs still loaded about an hour and a half before the scheduled landing time. He immediately called the Supervisor of Flying (SOF), the guy who keeps track of airborne jets, and said, "What the hell is going on here? Where are the other F-16s, and, specifically, where's the leader?" The SOF could only shrug his shoulders and say, "I don't know sir." It sure looked bad for the home team at this point: four jets on the ground back at the base with their bombs unexpended, two jets 500 miles away in Okinawa on the ground with unexpended bombs, and six jets unaccounted for somewhere over the East China Sea.

In 1954, the MiG-17 was produced. It was heavier than its MiG-15 predecessor, weighing in at 9855lbs empty and 15498lbs fully loaded. It also had a longer range, at 715 miles. However, its maximum cruising speed was only 630 mph, making it slower than the MiG-15.

Meanwhile, our remaining six jets had finally beaten the weather by flying about 175 miles out of the way. We soon found the island and pounded the target with our Mk-84s, 45 minutes after our scheduled Time on Target (TOT). After hitting the target, we followed the same path back to the tanker, refueled, and flew home. When I got within 100 miles of Kunsan I called back with an in-flight report that the target was destroyed. We landed five hours after takeoff (instead of three hours as planned). I went back to the squadron and debriefed the Intelligence Officer and gathered up the rest of the flight (except for the guys in Okinawa). We finally pieced together that "goat rope" of a mission, and everyone scattered to fly other missions.

Not much was said to me about the whole thing, and the Wing decided to downplay the raid and see what the inspector who flew on the mission reported. At the end of the week, the ORI ended, and we received the customary ORI debrief from the inspection team. They rated the raid on Torishima a success, despite the somewhat unorthodox execution of the mission. There is no doubt that I lost some style points, but the inspector that flew with me on the mission said, "The bottom line on the Torishima raid was that the target was destroyed and that all of the jets returned safely."

After the debrief, everyone gathered in the bar for the post-ORI celebration. Soon after the party started, a few guys got up and said that they had written a song about the Wing's most memorable experience during the ORI. It was sung to the tune of "Sink the Bismarck," and it was entitled "The Torishima Raiders." It is not in my best interests to reveal all of the words to this song; fighter pilots don't make up songs (or their own call signs, for that matter) to flatter anybody, and this song was no exception to that rule. I will give you the first few lines, which went something like this:

It was March of 1982 and the Wolf Pack got the task
A raid on Torishima was all the inspectors asked
Attack Torishima, that was the battle sound

> But the TOT came and went, and the Wolf Pack was nowhere to be found.

Well, as the saying goes, live and learn. On the Torishima raid I overreacted to the weather and almost lost sight of the reason I'd strapped into the jet that morning. There are only two objectives when you go out to beat mud (fly a ground-attack mission): destroy the target and survive to fight another day. Everything you do during that mission should move you closer to those two objectives.

This chapter will give you basic air-to-ground techniques that will help you achieve the fundamental objectives of the Falcon 3.0 air-to-ground missions. It does not contain all of the answers, however; you will still have to learn from your own mistakes just as all the other fighter pilots do.

Falcon 3.0 Air-to-Ground Fundamentals

Aircraft cannot hold and control territory on the ground. This job is done primarily by a soldier on land with an M-16. The fighter pilot is always aware of that soldier and knows that both of them are part of an orchestrated air and land battle with the ultimate goal of defending or capturing ground objectives.

Every war fought with aircraft has proven that air superiority is the most important mission flown by tactical aircraft. Without air superiority you cannot perform other vital missions such as ground attack, reconnaissance, and air resupply. While air superiority is a prerequisite to victory on the ground, having air superiority does not guarantee victory. While the modern battlefield is dominated by weapon systems such as tanks and aircraft with incredible mobility and firepower, the outcome of the battle still rests primarily on the shoulders of the infantrymen. At some point, if the air battle is successful, the F-16 weapon system will be utilized in support of these men on the ground; at this point the F-16 will start "beating mud" and "moving dirt" to accomplish this mission.

Attacking ground targets is fundamentally the same as attacking aircraft except that ground targets don't move as quickly and the attack geometry is much easier to understand. In this chapter you will learn techniques for employing three categories of air-to-ground weapons in Falcon 3.0: the point-and-shoot weapon, the free-fall bomb, and guided ordnance. All of these weapons are delivered from a diving attack.

Point-and-Shoot Weapons

You use point-and-shoot weapons in the Falcon simulation by strafing with a 20-mm gun or firing air-to-ground rockets.

Strafing

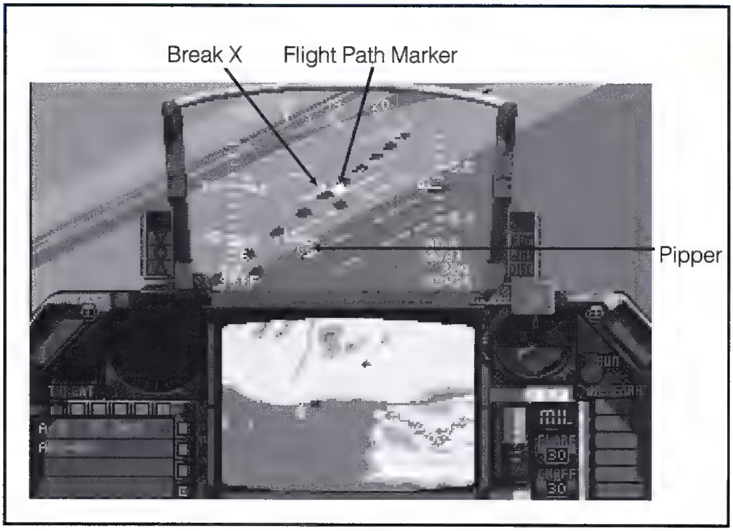
The 20-mm gun is a point-and-shoot weapon that is very straightforward in Falcon 3.0. At the end of Chapter 4 you learned about the associated HUD symbology for strafe and how to call up the gun for an air-to-ground attack. This section will cover the tactical use of the gun.

The 20-mm gun in Falcon 3.0 is a great weapon to use when you are in tight on a soft target and you don't have time to set up the attack. The other Falcon 3.0 air-to-ground weapons take a lot more time and distance to employ. You can quickly call the gun up, point at the target, and shoot. The bullets fly out the gun barrel and head straight for where you pointed them. When things are happening too fast and you can't get lined up for a bomb or missile attack, draw your gun and execute the following steps:

1. Select the air-to-ground Strafe mode.
2. When the target comes into view, fly the jet so as to place your Flight Path Marker (you should remember what the Flight Path Marker is from your first Red Flag training flight in Chapter 3) below the target, as shown in Figure 7-1.

Figure 7-1.

A cockpit view of a tank on the receiving end of the Vulcan 20-mm cannon



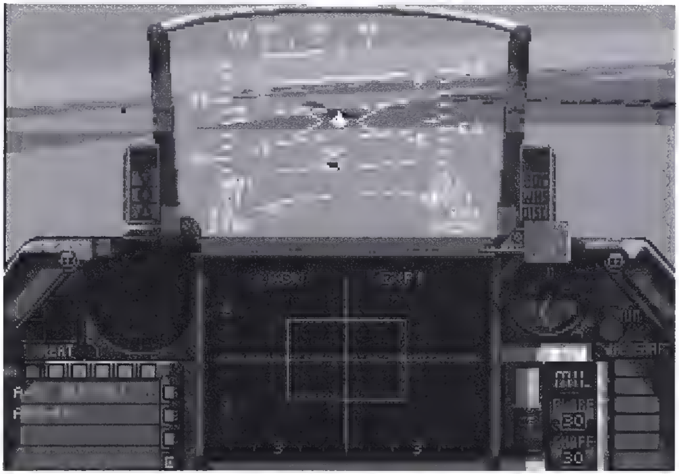
You're probably thinking, "Why don't I just aim at the target?" It is easier to aim the gun if you place the jet on a flight path below the target and fly the Aiming Reticle up to the target. There are two reasons why aiming below the target makes strafing easier. First, as you start to bring your Aiming Reticle up to the target and concentrate on shooting, you will shallow out your dive angle instead of getting steeper. This is important because the steeper your dive at the target, the more altitude you will need to pull out without hitting the ground. If you initially point your Flight Path Marker above the target, you will have to dive more steeply while you are aiming and shooting. This could easily put you in a bad position in relation to the ground (too steep and too low).

The other reason not to point above the target applies mainly to the real F-16. If you point above the target you will have to push negative *G*s to line up with it, and that is very uncomfortable when flying low to the ground on a strafing run. Negative *G*s feel like going downhill on a rollercoaster.

3. Fly the M61A1 cannon pipper to the target, as shown in Figure 7-2, and hold it there.
4. Open fire on the target by pressing the SPACEBAR or button 1 on your joystick. You can hold down your fire button as you keep the cannon pipper over the target, but remember that while ammo is cheap, it isn't limitless (especially when you're airborne), so it's wise to keep some ammo in reserve in case you go "Winchester" (run out of air-to-air missiles) and you have to defend yourself against some unwelcome company on your flight back home.

Figure 7-2.

The F-16A HUD in STRF mode with REO displaying the radar in Ground Map mode



5. After firing a two-to-three-second burst, check your position in relation to the ground and think seriously about pulling up. Even if you are not close to the ground, you will have been flying a very predictable flight path for long enough. The POW camp is full of fighter pilots who flew a predictable flight path for too long.

Believe it or not, this really is an easy weapon to use once you get some practice. The key to strafing in Falcon 3.0 is initially aiming below the target and then gradually pulling the pipper up to cover the target.

Firing Air-to-Ground Rockets

Firing air-to-ground rockets is similar to strafing a ground target. If you have loaded up the LAU 5003A rocket launcher, select this and fly to your target as if you were in a strafing run. Place the pipper directly on the target and let fly with a salvo.

Bombing

The free-fall bomb is the primary air-to-ground weapon used by aircraft throughout the world. In Falcon 3.0 there are six types of free-fall bombs: the Mk-82, the Mk-82HD, the Mk-83, the Mk-84, the CBU-84, and the Durandal. The weapons specs were covered in Chapter 4; review them and become familiar with choosing the right ordnance for the right mission. This section will address employing these weapons in the simulation. Before we discuss actual techniques, there are a few things that you should know about dropping bombs. Figure 7-3 shows a side view of the bombing triangle. This triangle shows you the geometry of a bombing run; this helps you visualize the mechanics of the attack. The diagram includes the following terms:

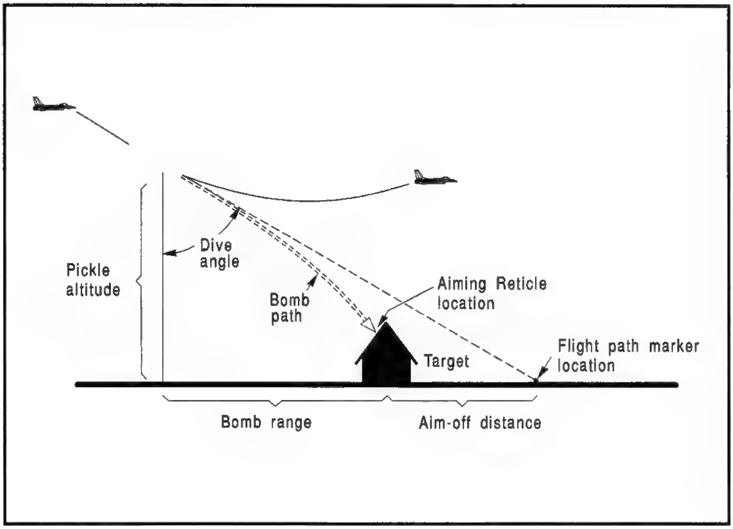
- *Aim-off distance* is the distance, measured in feet, from the Flight Path Marker to the target.

- *Bomb range* is the horizontal distance, in feet, from the aircraft to the target at bomb release.
- *Dive angle* is the angle, measured in degrees, between the flight path of the jet and the horizon.
- *Pickle altitude* is the height, in feet, above the ground at bomb release.

Dropping bombs is slightly more involved than strafing because you have to overfly the target in a dive and line up your aiming symbology in order to accurately drop a bomb. You can't make corrections once you pass over the target. In a strafe attack, the target always stays in front of your jet, allowing you to adjust your aim point while you're shooting. The Falcon 3.0 CCIP HUD bombing symbology was discussed in Chapter 4, along with some basic bombing tactics. Here,

Figure 7-3.

A side view of the bombing triangle



you'll be taken step by step through taking out ground targets. The next section will cover how to use the CCIP (Continuously Computed Impact Point) bomb symbology to accurately deliver your ordnance.

1. Select the desired free-fall weapon.
2. Fly straight at the target at 2,000 to 4,000 feet above the ground.
3. Note the position of the target in your HUD in relation to the Pitch Lines. When the target is between 5 and 20 degrees below the 0 Pitch Line, start your attack. Figure 7-4 shows the target in the correct position in your HUD.
4. Start the attack by flying your Flight Path Marker above the target, and put the target one third of the way down the CCIP Bomb Fall Line, as depicted in Figure 7-5.
5. Hold the Flight Path Marker steady in relation to the target and adjust the flight path of your jet to keep the Bomb Fall Line through the target. Remember that the Bomb Fall Line shows the future path of the bombsight or pipper, also known as the Death Dot. This is the point in the bomb run when you must ask yourself the crucial question: "By the time my bombsight gets to the target, will my pickle altitude (altitude when you release your bombs) be high enough to allow me to pull out of this dive?"

   A good way to know the answer is to watch the break X (> and <) symbols in the HUD or listen for "Bitchin' Betty" (Falcon 3.0's voice messaging system) to tell you to pull up. If the answer is yes, go on to step 6. If at any time as you approach your target, you see a big X in your HUD (the > and < having moved together), then the answer to this question is no. Pull up out of the dive and pickle as the target goes through the bombsight. This is not an accurate way to deliver the bombs because the bombsight will pass through the target very quickly,

***Note:** You must aim above the target with your Flight Path Marker and achieve some aim-off distance or you will plant your rear end short of the target without ever getting the bombsight over it. Plowing into the ground in this manner lacks style and is very unhealthy.*

Figure 7-4.

The F-16A HUD in CCIP (Continuously Computed Impact Point) mode. Note target position prior to bomb run

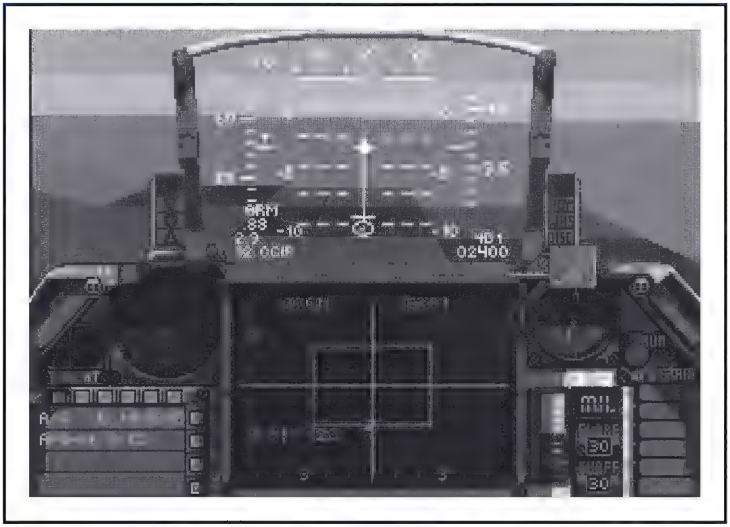
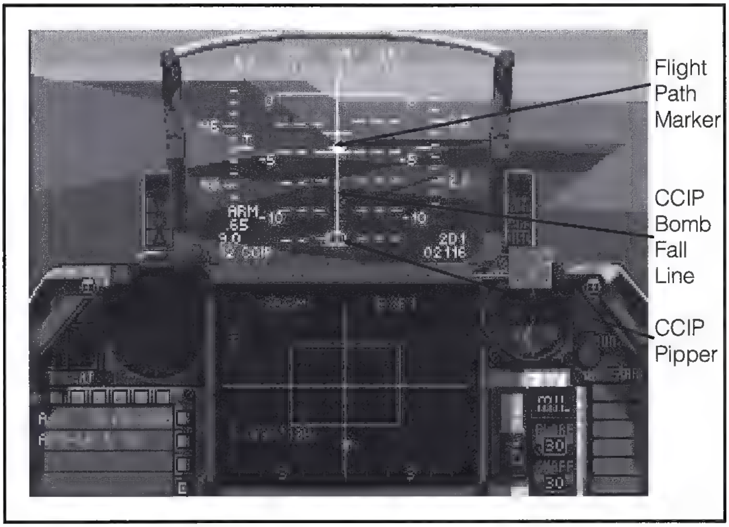


Figure 7-5.

Target position in the F-16A HUD during bomb run



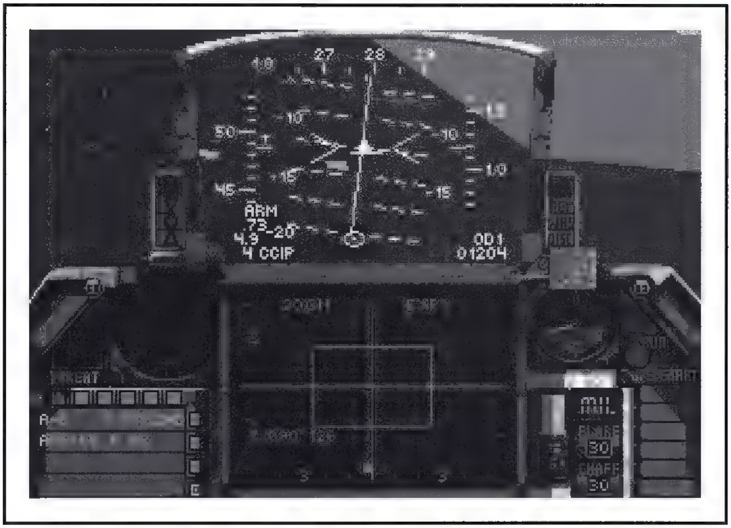
giving you only a split second to pickle. However, in this situation it is a good idea to trade bomb accuracy for survival.

6. Watch the pipper track up to the target and when it intersects the target, press the SPACEBAR (or button 1 on your joystick) to lock your pipper on the ground target. Figure 7-6 shows the pipper over the target at release.

7. You must continue your approach to the target until you see the Displayed Impact Line reach the center point in the HUD. The release symbol signals that the bombs are on their way to beat mud (and with any luck destroy the target). You can prematurely release them by pressing SPACEBAR again. The reason you would prematurely release your bombs would be in response to any change in flight path necessitated by the sudden appearance of an enemy threat.

Figure 7-6.

CCIP Aiming Reticle position at bomb release



***Remember:** Keep in mind that the greater the angle of your approach, the less time before your bombs explode, since a steeper bomb trajectory angle will result in quicker target acquisition.*

8. After bomb release, pull up and get away from the target. If you want to check and see where your bombs hit the ground, pull up into a 40 to 60 degree climb and press the 5 key to look directly behind you. With some practice you can use this technique to check the accuracy of your bomb deliveries. Be careful, though, of putting on this type of air show and admiring your handiwork. The enemy will more than likely show his appreciation of your acrobatics over the target area by presenting you with your very own surface-to-air missile.

Snakes

All free-fall ordnance is delivered in the same manner, including snakes and durandals. Snakes are retarded (high drag or HD) ordnance, designed for low-level bombing runs. Once ejected off the racks, their drag gives you time to get clear of the pending explosion.

The BLU-107/B Durandal

The BLU-107/B Durandal is an anti-runway munition that is employed in a similar manner to other free-fall ordnance (as described in Chapter 4) in that it is ejected off the racks over the target; it free-falls to a predetermined height where it is then slowed by a parachute over the target until a high-speed rocket motor kicks in and drives it through the concrete of the runway. It then detonates when the warhead is underground, causing considerable cratering of the runway.

The CBU-84 Cluster Bomb Unit

The CBU-84 Cluster Bomb Unit, also described in Chapter 4, disperses 200 antipersonnel bomblets. Drop one of these on a runway you have damaged with a Durandal to slow repair efforts.

Guided Munitions

You can choose several guided munitions to help you complete your job.

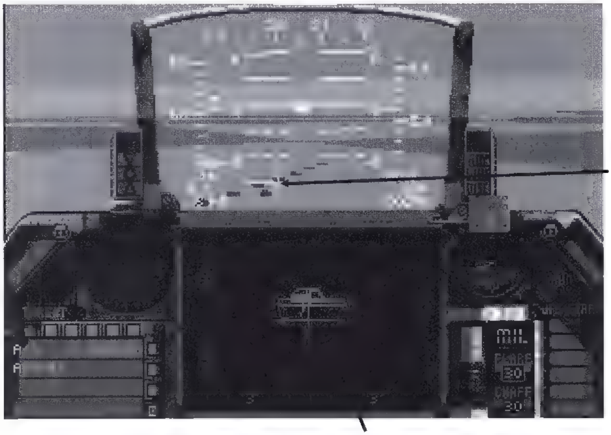
The Maverick Missile

The Maverick is a lock-and-launch guided missile, which means it requires the pilot only to lock-on to the target and launch the missile. There are two types of tracking systems on the Maverick: electro-optical and infrared. Employment of the Maverick is similar to strafing because you must point directly at the target in order to fire. Once the missile is fired, the pilot can maneuver the jet freely and does not need to keep flying toward the target. The following steps will help you kill targets with the Maverick missile:

1. Select the Maverick.
2. Roll in on the target and place the Maverick Aiming Cross below the target.

You do this for the same reason you did it in strafing. It is easier to fly the Aiming Cross up to the target after you stabilize the jet on the attack, rather than trying to point directly at the target as you are maneuvering to attack.

3. Fly the Aiming Cross up to the target.
4. Wait for the Maverick to lock-on—when your target's image appears in your REO, as shown in Figure 7-7, you have achieved lock on the desired target. Press the SPACEBAR or button 1 on your joystick to launch the missile. If you do not get a lock-on to the correct target press the X key to break lock, and then give it another try.
5. Once you launch the missile, you may want to follow its trajectory by pressing Q to cycle to the missile view—just don't waste too much time here. Press the 3 key to get



Maverick Aiming Cross

Maverick Aiming Cross

Figure 7-7.

The Maverick Aiming Cross in position, target acquired, just prior to Maverick launch

out of the missile view and back into normal HUD view and then turn away from the target area.

6. As you are *egressing* (exiting the target area) press the Q key again to watch the missile impact the target. If you are not in a high-threat situation, you can switch back to a normal HUD view after step 5 and watch the Maverick fly to the target. The problem with this technique is that your flight path is predictable for a long period of time. The Maverick missile is the best weapon to use in a high-threat environment because of its stand-off capabilities. You do not have to get as close to the target as you do when dropping the free-fall ordnance. In addition, it is easier to assess the results of your attack.

The AGM-45A Shrike and the AGM-88A HARM

The AGM-45A Shrike and AGM-88A HARM (High-speed Anti-Radiation Missile) are designed to home in on radar installations using their own radar transmissions (as you learned in Chapter 5). By taking out a radar installation, you are, in effect, blinding your enemy—especially their SAMs. You are not only saving your life, but perhaps the lives of your fellow pilots on later sorties as well. The AGM-45A Shrike is the cheaper, more plentiful anti-radar or anti-radiation missile, but it has an effective range of only 12 miles and targets only continuous wave radar systems. The AGM-88A HARM is effective against continuous wave and pulse-Doppler radar systems and has a range of 30 miles. However, the HARMs are more expensive, so they will be in shorter supply during your campaign.

Firing the HARM or Shrike missiles is very similar to using the Maverick. You will notice that the Aiming Cross will track to the nearest radar transmission target. Once it locks on, it remains locked as long as the target is within the forward arc of your F-16. Mavericks, however, lose lock when the target goes outside your HUD.

By 1965, the Soviets were producing MiG-23s. The MiG-23, a considerable improvement over previous MiGs, flew at Mach 3 and had a cruising altitude of 88,580 feet.

The GBU-15 Guided Bomb Unit

The GBU-15 guided bomb unit is a "smart" bomb that carries the firepower of an Mk-84 and also carries an electro-optical or TV imaging tracking system. When this munition locks on to a target, it uses control fins to glide on target. This weapon is quite expensive (and heavy, at 2510lbs), so you'll want to save this bomb for very important hardened targets such as command bunkers or nuclear weapons facilities—any large target whose removal you need to ensure.

This weapon is employed much like an AGM-65 Maverick. When you have selected the GBU-15, an Aiming Cross will appear in the middle of your HUD. Line the Aiming Cross up with your target. An image of the target will appear in the REO when your GBU-15 locks. Break the lock, if desired, by pressing the X key on your keyboard. You can release the GBU-15 from a maximum of five miles out, depending on your angle of approach towards the target. For best results, wait until you are fairly close to the target—in other words, as close as you would be to drop a bomb. Since the GBU is a guided weapon, it is dropped immediately when you press the SPACEBAR or button 1 on your joystick, without the delay experienced when dropping dumb bombs in CCIP mode.

Reaction to a SAM Threat

There are three types of enemy SAMs in Falcon 3.0: the CW radar-guided SA-6, a medium-range mobile SAM; the short-range, shoulder-launched IR-guided SA-7; and the pulse-Doppler-guided, short-range, low-altitude, mobile SA-8. You will also find 23mm AAA–the CW radar-guided, short-range, mobile ZSU-23-4. This section will give you a few survival techniques for your clue bag. When the SAMs start flying, there are no surefire ways of avoiding or defeating them. If you want to be completely safe, don't take off in the first place. At some point, your country will require the fighter pilot to get in harm's way. Keep in mind that you can set the effectiveness level of SAMs in the Config screen from the War Room.

Using the Threat Indicator

In Falcon 3.0 the only dependable way to tell if you have been engaged by a SAM is by checking your Threat Warning Indicator. This gauge will give you an audio and visual signal for radar SAM lock-on ("LCK" on your Threat Warning panel) and launch ("LNCH" on your Threat Warning panel), and you may be able to tell what type of radar is tracking you on your threat warning scope by the number inside the threat diamond blip. (See Chapter 6 for a list of these radar warning numbers.) For IR SAMs you will only get a launch indication because the SA-7 does not have radar associated with it.

Reacting to SAMs is similar to the defensive BFM procedures covered in Chapter 6. A minimal amount of creative thinking is required when you become engaged by a SAM. What is required by the fighter pilot is reaction. Unfortunately, in air combat quickly reacting the wrong way won't work.

What will work is executing a sound game plan quickly and correctly as soon as you become engaged by a SAM.

The steps discussed shortly outline a game plan that will help keep you alive when your jet turns into a SAM magnet. All of these steps are based on you detecting a SAM in your Threat Warning Indicator. If you do not detect a SAM launch with your Threat Warning Indicator then you are bound for the meat locker and the following procedure won't help you.

Missile Lock-On Indication

When engaged by the SA-6, SA-8, or the ZSU-23-4, you should get a lock-on indication in the Threat Warning Indicator. This indication will appear as a "LCK" on the panel to the left of the circular scope on the Threat Warning Indicator. (If you need a review of what this looks like, refer to Chapter 5). In addition to this visual display you will get an audio indication of radar lock-on that consists of a beeping sound. Don't worry about which type of ground threat is locking on to you: you can't tell for sure and if the SAM hits its target, it won't matter what type of missile got you. What is important is that you execute the following steps as soon as you get a SAM lock-on indication:

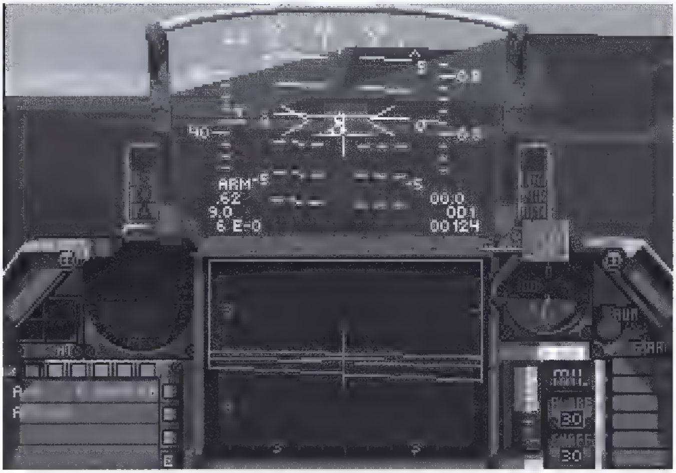
1. Turn on your ALQ-131 jamming pod immediately by pressing the E key. If you don't have a jamming pod loaded, you'd better hope the following steps work.
2. Dispense chaff by pressing DEL.
3. Descend to lower altitude and go to AB as fast as you can. It is a good idea to get down to 500 feet to avoid radar-guided threats, but beware of the short-range, low-altitude SA-7, SA-8, or ZSU-23-4. If the lock-on indication goes away, turn off your jamming pod and continue with your mission. Be ready to repeat the steps if a SAM locks you up again. If you do not break the lock-on of the SAM, keep flying fast, low, and unpredictably with your jamming pod on, and keep dispensing chaff.

Missile Launch Indication

If a lock-on indication turns into a missile launch indication, you are very close to getting morted. Again, don't worry about what type of missile is being fired at you. Execute as many of the following steps as you need to avoid the SAM. After a SAM launch at your jet, you have the rest of your life to react correctly. Remember to dispense both chaff and flares *throughout* the following steps:

1. Check your jamming pod to ensure that it is on (if you have one loaded).
2. If at medium altitude, perform a slicing maneuver at high *G* to low altitude. Figure 7-8 shows a cockpit view of this maneuver. Be careful you don't double dribble yourself off the ground. If you are at low altitude perform a hard *G* turn with at least 90 degrees of heading change.

Figure 7-8.



A cockpit view of a slice to low altitude. Note that altitude is 124 feet and speed is 410 knots

3. If you are still alive, get ready for the next missile by going as fast as you can and getting lower if you are not already on the deck.

Ejection

If you do everything correctly and still get hit by a SAM, it's time to ride the old nylon elevator down to mother earth. When you can no longer control the jet due to battle damage, press CTRL-E three times to bail out. Once you have lost control of the aircraft do not delay ejecting.

Moving Earth

There is no doubt that moving the mud with bombs is a thankless job. The guys that fly the air-to-ground sorties do most of the dying and get a lot less recognition than the guys flying air-to-air. Despite this fact, destroying ground targets with fighter aircraft is an essential part of the war effort. Nowhere was this more graphically displayed than in the Iraqi conflict. Iraqi forces, pounded relentlessly from the air, had no stomach for fighting when the ground forces closed in. When the enemy parks tanks on your airfield, you really have lost the war. The next chapter will lead you through planning a mission and will discuss the tactical considerations of a Falcon 3.0 ground-attack mission. Somebody has got to stop the enemy war machine, and that somebody is you.

Note: *During a SAM launch, you must use all of your ECM, put high Gs on the jet, and fly unpredictably. It is very difficult to see a SAM coming at you in Falcon 3.0 so don't base your SAM defensive game plan on picking up the missile visually. If you do, you will begin your defensive reactions just about the time the missile is exploding. Also, keep your eyes open for AAA (Anti-Aircraft Artillery).*

CHAPTER

8

CAMPAIGN SURVIVAL IN AN F-16

"No battle plan survives contact with the enemy."

– Gary Bloedorn
Col. U.S. Army (retired)

Knowing how to fight a MiG one-on-one or how to drop a bomb on a target does not necessarily translate into success in Falcon 3.0. These and the other techniques discussed thus far are just basic skills. Once you have these skills, you need to be able to apply them in Falcon 3.0's tactical environment.

This chapter ties together all of the basics, describes some advanced techniques, and teaches you to plan and fly a mission in a campaign. In addition, it provides hints on managing your resources, both machine and human, during a campaign.

The key to formulating a successful plan is understanding the mission objective and your capabilities compared to the known and expected enemy threats. Your overall mission objective is always to destroy an enemy ground or air target and survive. In order to do this you must minimize your exposure to the enemy threat systems and fly an attack that will give you a reasonable chance of success. The probability of killing the target must be carefully weighed against the probability of your jet being shot down; any plan you devise should balance these two factors.

The Tactical Environment

The *tactical environment* consists of the air and land battle area and the disposition of friendly and enemy forces within this area. The enemy's capabilities, the Falcon's capabilities, and the terrain all make up the tactical environment. In Falcon 3.0 this environment changes as you change the level of the game; however, the steps that you take to plan and execute a mission do not change from campaign to campaign.

The enemy has the single biggest impact on your ability to execute your mission. If there were no enemy fighters to contend with, there would be no need for tactics. You would just fly along at about 5,000 to 10,000 feet, circle around the target until you were perfectly lined up, and then bomb it from an altitude that would give you the exact impact angle that you desired–just like the earlier training missions you flew. But you know from playing the game that this approach won't work. Every target in Falcon 3.0 that is worth bombing is defended by the enemy. Your mission plan will have to take this threat into account or you will end up wearing a lot of enemy missiles before you even get close to the target area.

What You Know

Falcon 3.0 allows you to simulate combat in a specific campaign. The theaters of conflict provided with the basic Falcon 3.0 simulation include Kuwait, Israel, and Panama. Each campaign is a series of interlocked missions with differing goals. For instance, you may be called to escort bombers, cover retreating ground units, or undertake a strike yourself. There are other types of aircraft that may assist you, although you are in command of an F-16 squadron.

The War Update Screen

Prior to each mission Falcon 3.0's War Update screen will give you campaign objectives, which delineate the strategies and objectives to win that particular campaign.

The Campaign Information Screen

You will receive specific logistical information, such as weather and time, planes and pilots available, and resupply and replacement dates from the Campaign Information screen.

The Mission Planning Screens

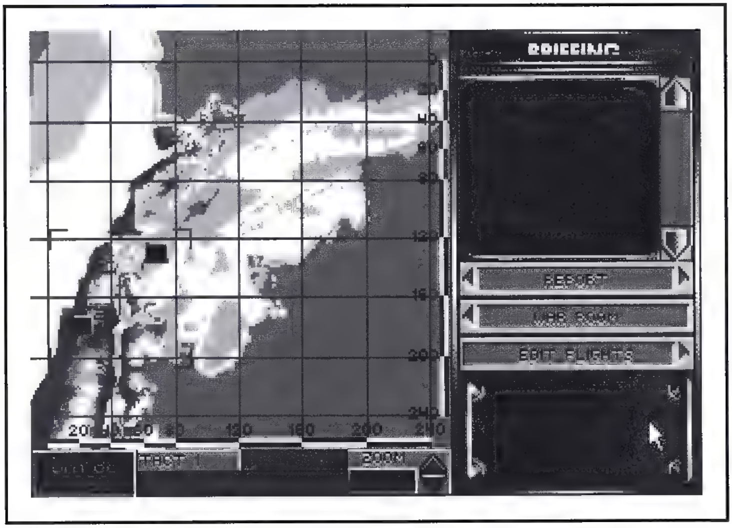
Several more screens exist to help you plan your missions. The most significant of these screens are the Briefing screen, Edit Flights screen, and Set Waypoints screen. Each screen is discussed in the following sections.

The Briefing Screen

The Briefing screen, shown in Figure 8-1, provides specific mission objectives for your upcoming flight as well as a map of the area. You can zoom in on a

Figure 8-1.

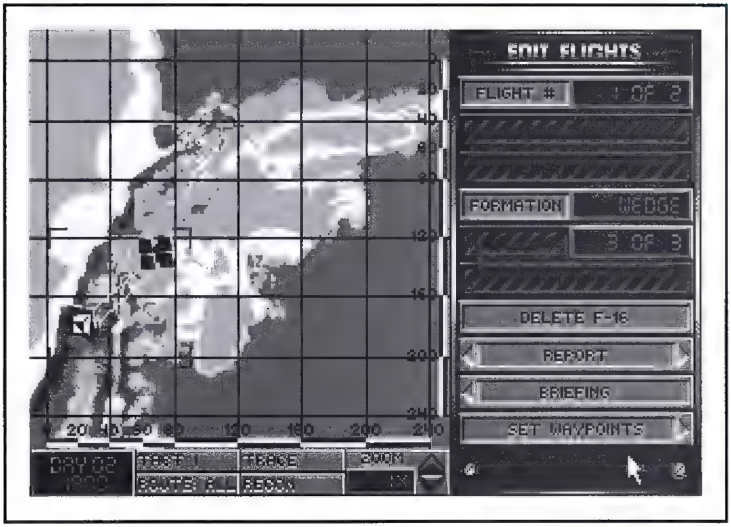
Briefing screen



specific area through levels of detail, with the highest level of detail being a three-dimensional representation of the terrain.

Use the Briefing screen to develop the tactical plan that you will use, a plan based on the position of the enemy threat. Before flying a mission, note the location of the enemy by using the Tact/Strat views as well as the Zoom functions on the Briefing screen, the Edit Flights screen, and the Set Waypoints screen. With this information you can construct your game plan to avoid flying near the sites of enemy threat systems whenever possible, as discussed later in this chapter.

The Edit Flights Screen The Edit Flights screen, shown in Figure 8-2, is where you can set up your flights. Aircraft may be either added or deleted as desired. Additionally, separate flights of aircraft may be either added or deleted, and aircraft formation for each flight may be determined here. For instance, one flight may be set up as an air-to-air CAP (Combat



FLIGHT # 1 OF 2

FORMATION WEDGE

3 OF 3

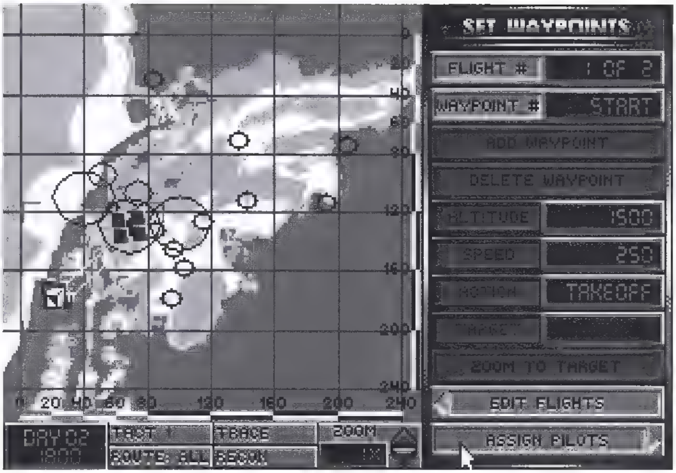
Figure 8-2.

Edit Flights screen

Air Patrol), while a second may be set up as an air-to-ground (Search and Destroy) flight.

The Set Waypoints Screen The Set Waypoints screen, shown in Figure 8-3, is especially helpful in planning your flight. You can set the waypoints for your flights so that a CAP flight arrives over a target area first, clearing out any enemy aircraft that may be in the area. Then, again by setting waypoints, the strike flight (Search and Destroy) can be set up to come in after the CAP to take out the target with less chance of being intercepted by enemy fighters.

A waypoint is an arbitrary point in three dimensional space (a waypoint may have an altitude), that serves as a common reference point for plotting courses. In Falcon 3.0, waypoints are set up to denote changes in course. The final waypoint en route to a ground target is referred to as the initial point, or IP. In reality, waypoints are created in conjunction



FLIGHT # 1 OF 2
WAYPOINT # START
ALTITUDE 1500
SPEED 250
ACTION TAKEOFF

Figure 8-3.

Set Waypoints screen

with navigational aids such a VOR (navigation radio beacon). An example is when an air traffic controller instructs a pilot to fly to 30 nautical miles out on the 342 degree radial of a VOR at Angels 10 (10,000 feet), a common point of reference (a waypoint) may be established between the controller and the pilot. In Falcon 3.0, waypoints are specified in the initial briefing and you may edit them in the Set Waypoints screen by using either a mouse or the left SHIFT and arrow keys.

Notice the circles covering the Set Waypoints map. These are Threat Circles, which show the influence of enemy defenses. The Trace button on the Waypoints screen traces your flight plan and notifies you of enemy defenses. The accuracy of this information depends upon the Intelligence level you set in your Config screen. The Recon option on the Set Waypoints screen will give you an aerial reconnaissance of the last known position of enemy ground forces, but note that this information may be dated and inaccurate depending upon the age of the last reconnaissance report.

What You Don't Know

The saying "what you don't know can't hurt you" may be true concerning matters of the heart, but in combat what you don't know will kill you. Unfortunately when it comes to combat there are quite a large number of unknowns.

SAM Positions

In Falcon 3.0, one of the biggest unknowns is the position of SAMs, since all enemy SAMs are mobile. SAMs are probably the most dangerous threat to your F-16. To complicate matters, the Padlock view will not lock-on to a SAM in flight.

The range of the SA-6 is about 30 miles when the Falcon is flying at medium altitude. At low altitude the range of these SAMs is sharply reduced and their performance severely degraded; thus the best way to avoid getting hosed by an SA-6 is to get low and stay low when you are within 15 miles of the SAM site.

The SA-7 is a highly mobile shoulder-lodged, heat-seeking SAM, carried and fired by enemy soldiers. Since you do not

***Note:** One warning about bandits in Falcon 3.0: if you have your ALQ pod turned on and you are not being engaged by SAMs, a bandit will home in on your pod transmissions. For this reason only turn the pod on when your Threat Warning Indicator shows enemy missile lock-on or launch.*

know the position of every individual enemy running around the battlefield, you can't know the positions of these SAMs. But the SA-7 is a small SAM and has a range of about one mile, so you can avoid it entirely by either flying above 10,000 feet or flying very low and fast. Speeds over 500 knots and altitudes of less than 1,000 feet make it very difficult for the missile to hit your jet. High-altitude flying works best but you must determine the position of the SAMs and their range before you start driving the Falcon around above 10,000 feet.

Bandit Positions

Another very dangerous unknown is the position of the enemy bandits. Aircraft are obviously highly mobile and flexible in their engagement doctrine. They may lie in wait over enemy lines, or they may cross into friendly territory and attack you over your own airfield. But the good news is that your Falcon has excellent sensors to detect attacking bandits.

F-16 Capabilities

The threats are intimidating but the F-16 does not enter the tactical environment defenseless. The jet is well equipped to destroy the enemy and survive to fight another day. The tools for achieving success in combat are weapons, countermeasures, maneuverability, and a pilot who can think on his or her feet.

Weapons

When you build your tactical plan for destroying the target you must think carefully about your choice of weapons. Your primary consideration should be the probability that the chosen weapon will destroy the target. For example, shooting Mavericks at a runway would be a waste of time because they will not sufficiently damage runways. Instead, use an anti-runway munition such as the BLU-108 Durandal. When several weapons can be used to destroy a target, you must consider how easy each weapon is to employ and how much exposure you will have to any danger during weapon delivery.

Countermeasures

The F-16 has three basic countermeasure systems: chaff, flares, and the jamming pod, as discussed in Chapter 6. While these systems can greatly impact your ability to accomplish a mission, you must keep in mind that these are defensive systems and as such are of limited value–you want to be on offense. When dealing with the enemy, you want to attack and destroy–not run and hide. However, for those cases in which you can't launch your attack before a hostile launches standoff weapons, you can preserve your hide with countermeasures. Use these countermeasure systems when you are engaged by the enemy, but do not count on countermeasures to defeat the enemy. The best way to survive the air battle in Falcon 3.0 is to build a mission plan that avoids as much of the known threat as possible and that keeps you on the offensive.

***Remember:** Your airspeed must be close to 450 knots in order for your turns to be effective against SAMs or bandits. Any faster or slower and you will not be able to turn fast or tight enough. Use the throttle and speed brakes as necessary to achieve the proper airspeed once you start your defensive maneuvers.*

Maneuverability

The maneuverability of the Falcon, as discussed in Chapter 6, is one of your biggest advantages against the enemy threat systems. Remember that high *G* maneuvering, in combination with countermeasures, makes you a very difficult target to kill.

Terrain

The battle area has natural terrain and cultural features that you must be aware of. Mountains, buildings, and roads are the primary features that will affect your mission planning and execution.

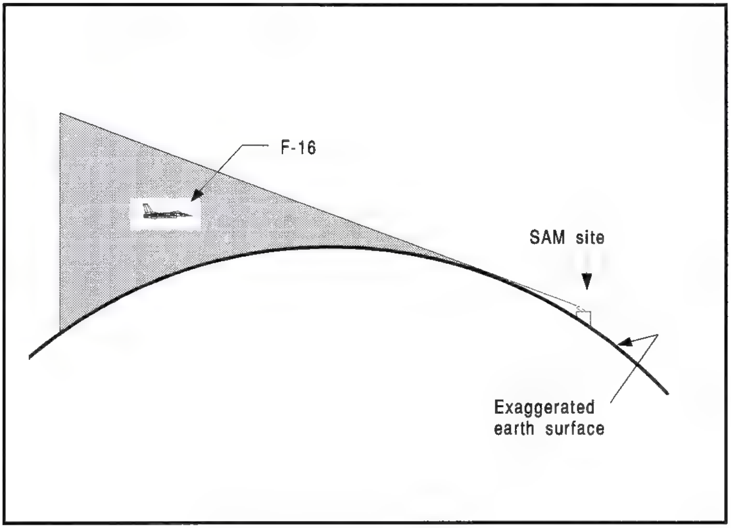
Mountains

Mountains can be used to mask your approach to the target; whenever possible, keep any mountains in the scene between your jet and the known SAM sites to shield your approach. If a SAM locks on to your aircraft, you may be able to duck behind a mountain to break the missile line of sight. (*Line of sight* is simply the ability of the missile or missile launch site to maintain a direct view of your jet.) The enemy's missiles will not be able to engage your aircraft, since line of sight must be maintained by the SAMs in Falcon 3.0 in order for them to guide to your jet.

Another factor that affects line of sight is the curvature of the earth. Figure 8-4 shows the combined effects of the curvature of the earth and the altitude of your jet on line of sight. If you fly below 500 feet, the SAM and radar sites will not pick up your jet until you are inside 20 miles. Using mountains and the curved surface of the earth to delay the enemy's detection of your jet is known as "Nape-of-the-Earth" flying.

Figure 8-4.

Curvature of the earth affecting line of sight



Roads

While roads are easy to see from the air and there is a natural tendency for pilots to follow them, avoid roads whenever possible. Remember that the enemy is conducting a battle and is moving troops and equipment on these roads, so when you follow a road you're more likely to find your enemy. The combat assets that the enemy moves along the roads will often be defended by SA-7s, so heads up. When you have to fly over a road in enemy territory, cross it as quickly as possible. And if you have to fly parallel to a road, offset your flight path five to ten miles to avoid unwanted attention from possible traffic on the road.

Remember: *Roads are only* potential *threat areas. You would rather fly near a road in enemy territory than a known SAM site.*

Buildings

Buildings should be avoided for the same reason that you avoid roads. The enemy tends to congregate in cities and towns, and has some stake in defending these areas, so fly around buildings whenever possible to avoid a possible SA-7 threat.

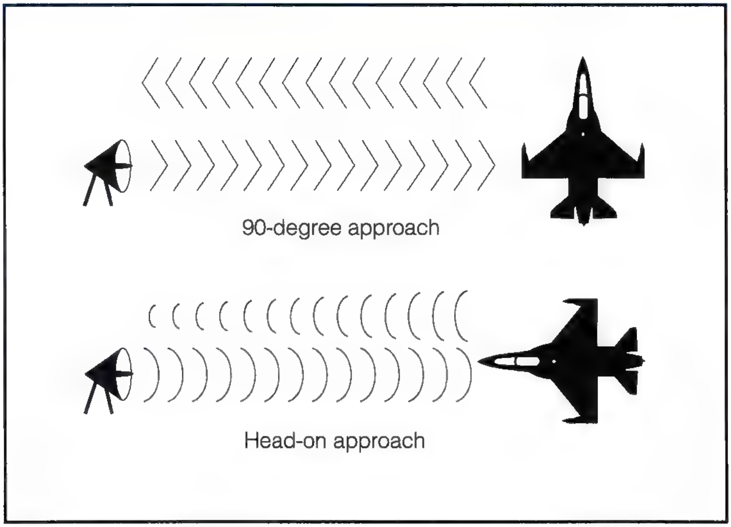
Radar Installations

Radar installations also pose an immediate threat to your aircraft. Defense networks will often use both pulse-Doppler and continuous wave radar (as discussed in Chapter 5) to ensure that they get a signature on your aircraft whether you are approaching or side-skirting that installation. Happily for fighter jocks, these radar cannot be placed close to each other or they will interfere with each other, so it is possible for you to weave through radar airspace, alternating a head-on approach (effective against pulse-Doppler systems) with a 90-degree approach (effective against CW radar). Figure 8-5 shows both a head-on approach and a 90-degree approach. Although your ALQ pod may jam the radar, your enemy will still know you are there.

Remember: *The SA-7 can be encountered anywhere in enemy territory, but you are most likely to encounter this SAM near man-made terrain features.*

Figure 8-5.

Head-on approach and 90-degree approach to different radar systems



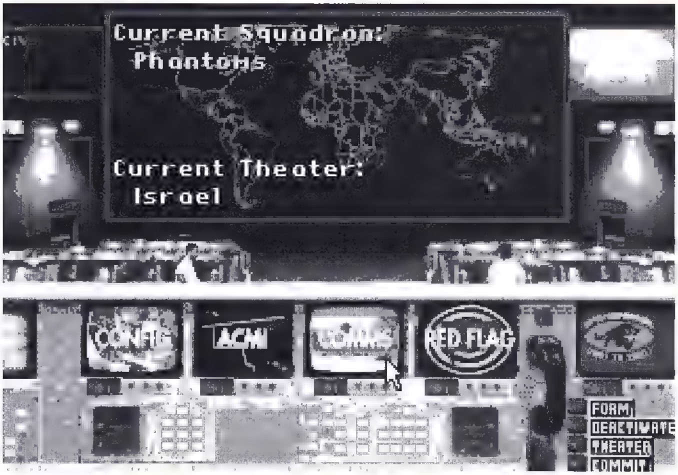
Your Responsibilities as Commanding Officer

When you choose to enter Falcon 3.0's campaign, you automatically become the CO (Commanding Officer), and can choose one of three realistic theaters in which to pilot your F-16. Figure 8-6 shows the War Room, from which you choose your theater of conflict.

You will receive missions from Command, and your job will be to complete the mission while minimizing your exposure to enemy threats. You'll also have to keep in mind resupply/replacement dates, and make sure your squadron is battle-ready at all times.

You have the following responsibilities:

- Assigning the proper number of aircraft to achieve the objective.
- Assigning squadron pilots in the most effective manner.
- Managing your weapons and stores supplies.



Current Squadron:
Phantoms

Current Theater:
Israel

Figure 8-6.

The War Room

Choosing Aircraft

Chapter 4 noted that today's military must balance the high and sometimes prohibitive cost of effective weapons—and thus their limited availability—against the benefits the military will reap using those weapons. Because of their high cost, planes are also limited during campaigns, so you'll have to assign the proper number of aircraft to achieve your mission objectives.

Economy is laudable, but the battlefield is no place to be a skinflint. Though Command may order you to lead a certain number of aircraft on a particular mission, don't be afraid to commit more fighters (which you do at the Edit Flights screen by selecting Add F-16). This doesn't mean that you should commit eight planes—the maximum available—to each mission. When assigning aircraft to a particular sortie, use flights of two; they are more flexible than fewer, larger flights and you can assign flights to cover more area.

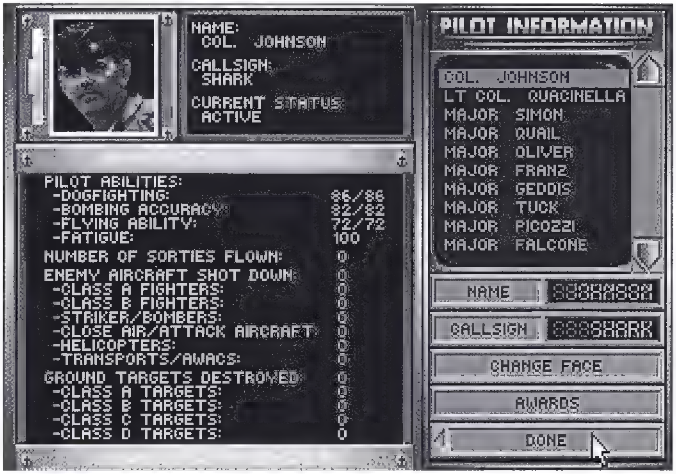
Pilot Selection and Management

Part of choosing the right weapons for the mission is choosing the best pilots for each mission. Review your pilot roster; you'll notice that each pilot has different skills and proficiencies in dogfighting, bombing accuracy, flying ability, and fatigue resistance. Keep a close eye on each pilot's current state based on fatigue and number of missions flown. Heavily used pilots, like pitchers in baseball, lose their effectiveness when they fatigue. So, if your best pilot is tired, letting him fly means you're likely to lose him.

You have 30 pilots with varying abilities and skills. When using the Pilot Information screen, shown in Figure 8-7, you'll see two numbers separated by a / for each attribute. The number on the right is the maximum that pilot is capable of and the left number represents that pilot's current state based on relative fatigue and number of missions flown.

Beware of your first tendency to pick the eight best dogfighting pilots and send them on every mission. As fatigue

Remember: *Rotate your pilots so that the poorer pilots will improve with increased flying time.*



```
NAME:
 COL.  JOHNSON

CALLSIGN:
 SHARK

CURRENT STATUS
 ACTIVE

PILOT ABILITIES:
 -DOGFIGHTING:                      86/86
 -BOMBING ACCURACY:                 82/82
 -FLYING ABILITY:                   72/72
 -FATIGUE:                          100
NUMBER OF SORTIES FLOWN:            0
ENEMY AIRCRAFT SHOT DOWN:           0
 -CLASS A FIGHTERS:                 0
 -CLASS B FIGHTERS:                 0
 -STRIKER/BOMBERS:                  0
 -CLOSE AIR/ATTACK AIRCRAFT:        0
 -HELICOPTERS:                      0
 -TRANSPORTS/AWACS:                 0
GROUND TARGETS DESTROYED:           0
 -CLASS A TARGETS:                  0
 -CLASS B TARGETS:                  0
 -CLASS C TARGETS:                  0
 -CLASS D TARGETS:                  0
```

```
COL.  JOHNSON
LT COL.  QUACINELLA
MAJOR  SIMON
MAJOR  QUAIL
MAJOR  OLIVER
MAJOR  FRANZ
MAJOR  GEDDIS
MAJOR  TUCK
MAJOR  PICOZZI
MAJOR  FALCONE
```

Figure 8-7.

Pilot Information screen

increases, the kill score of even the best pilot will drop below that of the worst pilot in the squadron; if severely fatigued pilots are not brought in, they are likely to be shot down, and be forever off your squadron.

A lot can be learned from history. During WWII, the Japanese kept all their top fighter pilots in combat and never rotated them. By the end of WWII, the Japanese had almost no experienced pilots left. The United States, however, took a different approach. Pilots with 30 or so kills were the leading aces (compared to 80+ kills for Japanese pilots) and were rotated back stateside to train other pilots. Overall pilot skill reached (and maintained) a high level for the U.S. and you know the rest of the story. So, if you want to win the war, you'll have to rotate the pilots. How are you possibly going to manage 30 pilots with names you've never heard before? Simple: change the names.

Changing Pilot Names

You'll probably want to name the CO after yourself and put in your callsign. Go to the Pilot Information screen, click on the pilot name in the upper-left window, then click on the Name box and change the name to something appropriate. Press ENTER and then select the Callsign box. Change the callsign and press ENTER. Scroll the window in the upper-right down one and follow the same steps to change the names of your squadron members.

What to Name Your Pilots

Use familiar names to name your pilots. You can use names of friends and family, other PC pilots, movie characters, actors–anything that is very familiar. Select callsigns that remind you of that pilot. If you use "Terminator," "Destroyer," "Killer," "Destructo," "Deathmonger," and "Doomslayer," you'll never remember who is talking to you when in combat. Put real-world nicknames in for callsigns, and keeping the pilots straight will be much easier. When you hear one of the callsigns, that particular pilot should come to mind almost immediately. All communication during flight in Falcon 3.0 is accomplished with callsigns. If you have multiple sections of aircraft it is imperative that you know who is talking to you.

Setting Waypoints

When you set waypoints, try to keep a Combat Air Patrol (CAP) other than your own around to keep the bandits off the attack group's back or to back you up. You can activate a CAP, also referred to as TARCAP, or Target Combat Air Patrol, by designating a flight in the Edit Flights screen and then assigning the CAP action for that flight. You can also assign actions to flights at any particular waypoint. The waypoint options are described in the following sections.

Nothing If you assign Nothing, the flight will continue onward to the next waypoint, but the pilots will defend themselves if attacked. They will not actively engage air or ground targets.

CAP (Combat Air Patrol) Assigning CAP means the flight will patrol the area along their flight path and will engage air units encountered. The flight will not attack ground units, nor will they pursue bandits far from their flight path.

CAS (Close Air Support) Assigning CAS means the flight will seek out and destroy hostile ground units and avoid air encounters. Due to the nature of air-to-ground combat, a CAS waypoint should be several miles from the previous waypoint to give pilots time to select weapons, alter altitude, and locate ground targets.

S and D (Search and Destroy) Assigning S and D combines CAP and CAS–the flight will engage and destroy both air and ground enemies.

Bomb Assigning Bomb means the flight will bomb the chosen target at the designated waypoint. Your wingmen will make one pass over the target and unload; they may also require several miles to prepare for a bombing run.

Intercept Assigning Intercept means the flight will aggressively seek out and destroy all air targets.

Loiter Using Loiter sends a flight back on a series of CAP waypoints if they have enough fuel. For example, if waypoints 2, 3, and 4 are CAP waypoints, and 5 is a Loiter waypoint, the flight will fly back to waypoint 2 to conduct another patrol unless they don't have enough fuel, in which case they will return to base.

Escort The flight will protect the path of Escort waypoints from incursion by enemy fighters. They will not engage aircraft that do not pose a threat to the escorted planes.

Land The Land waypoint is set at an airfield. It is the last waypoint on the flight, unless you create a bingo base. (A *bingo base* is an alternative airstrip set up in friendly or allied territory. You'll learn how to take advantage of a bingo base later in this chapter.)

Takeoff The Takeoff waypoint is where your F-16 takes off at the start of the mission. Your wingmen will be in the air waiting.

Setting Strategic Waypoints

You may wish to define more waypoints than the computer initially assigns. (The computer usually assigns only three or four waypoints circling the target area.) This ensures that the CAP patrol stays around long enough to cover your strike mission, after which they'll head for home rather than loiter indefinitely. The Loiter function is best reserved for defensive patrols along the front to stop all incoming enemy aircraft.

Remember, however, that once a CAP begins its flight sequence, there is no way to disengage before the last waypoint and go home. Therefore, even if you complete a strike mission, if more waypoints still exist on your flight path, the CAP planes will still be patrolling in enemy territory. And since you've taken offensive action (the object of your mission), you can be sure of an enemy response from SAMs and hostile air units. Don't risk the lives of your CAPs by prolonging exposure to the enemy response.

Don't Bring a Knife to a Gunfight: Munitions, Stores, and Fuel

It's important to pick the right munitions for the job; if you ask yourself some questions the night before your mission, you'll live to see the night after. Ask yourself: How hardened is the target? Can two or three F-16s carry enough ordnance to destroy it? How many different targets are there? For example, a lightly armored transport poses little resistance to a Maverick, but 40 transports is more than one F-16 can handle (and you can be sure they'll have some SA-7s to welcome you). Heavily structured targets will require more firepower to take out, and some heavy sites may contain two or more targets—multiple bridges, reactor towers, factories, and so forth.

Also, make sure you've got enough "other stores." If surface-to-air threats exist (more than zero units), carry ECM pods. But remember that ECM pods are heavy so don't carry that extra weight if you're flying a milk run. Assign them only to aircraft that need them.

Lastly, don't cut yourself short on fuel. Plan for the trip home.

Attacking Targets

Remember, your wingmen will follow your lead and will attack the targets defined in the Set Waypoints screen. You can only specify a single target at any given site, but you don't want to fly over a site more than once because of the omnipresent SAM threat. You can define multiple attack patterns against multiple targets, but make sure each strike flight has enough munitions to do the job. And keep in mind that different approach vectors will confuse enemy defense systems, or at least dilute the response.

SAM Sites

SAM sites are soft targets and are easy to destroy if you survive long enough to get your weapons off the jet.

The Maverick will work against a SAM site because it will allow you to stand off from the target. However, the Shrike and HARM missiles were designed to work against radar-emitting soft targets such as SAM sites. The LAU 5003A allows you to fire unguided rockets and pull away, but is effective only at close range. The Mk-82 HD and the CBU-84 are effective weapons against a SAM site and small buildings, but require you to overfly the target area. Use the M61A1 only if you have nothing else.

Remember: Never duke it out with a SAM site unless it is absolutely necessary (such as when your target is a SAM site or right next to one).

Tanks

The Maverick missile was invented to replace bombs in the role of killing tanks, so Mavericks are by far the best choice when attacking tanks. Use the bomb only if you can't use the Maverick.

Buildings

Mk-83s are your weapon of choice against medium-size strategic targets such as warehouses, barracks, hangars, and storage tanks. Mk-84s are 2000lb bombs that are better weapons against large structures such as bridges, factories, hardened shelters, and power stations due to the bigger blast and fragmentation effects that you get from a large bomb. The GBU-15 packs as much firepower as the Mk-84 and is optically guided, but it is more expensive and hence less plentiful during campaigns, so use the Mk-84s whenever possible, rather than the GBU-15s.

Bridges

The best weapon against a bridge is a guided bomb. Because the target is narrow, it's easy to miss. If you miss you have to re-attack, so you are better off using a GBU-15, which reduces your long-term exposure to the threat.

Runways

BLU-108/N Durandal Anti-Runway bombs are the only effective weapon against runways in Falcon 3.0.

Targets of Opportunity

In some cases, you may have a relatively easy mission and decide to take on targets not "authorized" by the high command. Anything is fair game, but the risk better be worth it. You probably will run up against some line of defense. The following tale comes from an experienced Falcon player who took the risk and had it pay off.

During a Falcon 3.0 campaign that took place in the Kuwait theater, a friendly airbase near my homebase was captured by the enemy on Day 1. The next day, enemy fighters were operating from that base and were jumping my aircraft as soon as they got airborne.

I saved the campaign files at the end of Day 1 to a backup directory and continued the campaign. The enemy fighters were all over me, and by the end of Day 2 I was assigned to escort bombers to the occupied field. I really hated to annihilate a good airstrip, so I began an experiment.

I restored the campaign files to the start of Day 2. The first mission of Day 2 was to intercept some inbound Tu-22s. I had six aircraft available so I took a chance. The intercept was tough (using veteran enemy logic level), but I figured two F-16s had a good chance of handling it. I defined another two-plane section to drop Durandals on the occupied runway, and I flew CAP for them.

Not having full resources to devote to the attack, and knowing that I might have to break off the CAP and intercept the incoming bombers lest I return home to a crater, I assigned stealth techniques to the strike aircraft: this meant fly low, carry ECM, and take AMRAAMs for self-defense.

The mission was a success. I got five kills, including two MiG-29s. The strike pilots reported "Bombs Away," but weren't credited with any ground kills. The enemy bombers had been destroyed. The next two missions that day I had "extra" aircraft, so I elected to continue the attacks on the airbase with second and third waves.

When the second wave arrived (six hours after the first), we had not had any air encounters with the enemy, and the runway had a huge black hole right where the runway connected to the taxi way!

The second wave targeted the command center. They dropped their bombs and we returned home. Once again the other flight had accomplished the primary mission, so I was still ahead of the game. I decided to target the hangars with the third wave, and I also carried a few Mavericks, just for good measure. When the third wave arrived (12 hours after the first attack), there was a light grey splotch on the runway where the hole had been, without runway marks. The runway had been repaired and was operational.

We hit the hangars anyway and destroyed most of them, and then flew home without incident. The primary had been accomplished without my intervention. Once again, Falcon 3.0 did not credit the pilots with the unauthorized ground kills.

The last mission of the day was a rough one. It was nightfall and massive amounts of enemies were inbound. I defined all available aircraft to cover the home field. It was a good thing I did as there were MiGs, Tu-22s, and Su-25s everywhere. We stemmed the attack, but had to let up pressure on the occupied base.

Did the missions make a difference? Well, the next morning friendly troops had recaptured the airbase, as well as other Iraqi positions nearby. The lack of available air cover no doubt hampered enemy installations. Of course, there were still black holes where the hangars should've been, but at least the runway was back in friendly hands.

The Threat Picture

After selecting your weapons, look at the known threats that lie between your airfield and the target area. You may want to send a wing or two loaded with HARMs and Shrikes on a suppression sweep to soften up defenses before the attack wing makes its way in. In addition to SAM sites, watch for roads and buildings that may be factors in plotting the mission. Targets will typically have two types of defenses: air cover and surface-to-air weapons (AAA and SAMs). Remember to use the map to determine what the enemy concentration is around the target, and check the icons in the Strat view for the location of any bases and airfields relative to the target. These sites will likely offer stiff resistance.

Be prepared for both air cover and surface-to-air weapons. If you're too heavily loaded with air-to-ground (AG) ordnance and fuel to fight surface-to-air weapons and don't have a CAP or escort around, you're not going to be able to dogfight air cover. In a case like this, when you're not well prepared, even the most trivial adversary becomes a legitimate threat.

The Attack Plan

It's time to build your attack plan. There is a saying about fighter mission planning: Measure it with a micrometer, mark it with chalk, and cut it with an axe. This means that the planning is done in great detail but the execution of the plan is not very precise. The reason for this is, of course, the dynamic nature of the tactical environment. You should still take the time necessary to construct a good plan. Just remember that things seldom go according to plan once the shooting starts.

Ingress

Even after you know who is flying what aircraft, you still have to decide how they are going to get to the target. Computer-generated default waypoints seem to employ a direct, up-the-front-steps approach that may conserve some fuel, but will very likely get you shot down.

The following sections mostly discuss computer-controlled aircraft. (The alternative is a human squadron, which has the ability to make on-the-fly decisions, as discussed in Appendix C.) Computer-controlled aircraft fly the waypoints as if they were engraved in stone. The following tips should not only help you survive, but also should increase the return rate of your squadron pilots.

Strike Sorties

Before sending strike aircraft into the lion's den, take a few minutes to check the Strat view on the Set Waypoints map. Look for the following things:

- How deep in enemy territory is the target?
- Is the target surrounded by hostile bases, or is one side bordered by friendly troops?

Using the Zoom view, observe troop locations and defense positions. The maximum Zoom view is your equivalent to satellite intelligence photos, and you should use it to its maximum advantage.

Coordinate your attacks to maximize the information you gathered as a result of you observations. If one side of the target is bordered by friendly units, use this as a corridor to bring your strike aircraft in. If the target is surrounded by hostile forces, you may wish to break the strike force into small, two-plane units, then attack from different directions (for example, one from the North and one from the East), and egress in different directions (for example, one section escapes to the West and one to the South).

The bottom line is don't take shortcuts when planning the waypoints. Take the extra time to use the additional views and intelligence available. It's there for a reason and may just save your simulated behind.

Remember: *Different formations have a different effect on enemy radar. Some will fool radar into thinking you have fewer planes than you actually do; some are better for air-to-ground engagements and others are better suited for air-to-air engagements. See Figure 8-8 for different formations of aircraft.*

Choosing Your Ingress Route

In choosing your ingress route, you should analyze the following factors:

- Positions of known enemy SAM sites.
- Positions of mountains that can be used to mask your jet.
- Buildings and roads that may be possible SAM sites.
- Altitude of your ingress and its effects on the known and expected SAMs.
- Speed of your ingress and its effect on your exposure to the enemy.

Calculating Your Speed and Fuel

While fighter pilots sometimes say that "speed is life," this must be weighed against fuel consumption. If you drive around in AB (Afterburners) for too long you'll suck the Falcon fuel tank dry, at which point you'll discover that a flamed-out F-16 flies just like a LA-Z-Boy recliner. You should always take an external gas tank in Falcon 3.0 since you can never have too much fuel.

Using Bingo Fields

You can get by with less fuel and more munitions by making use of a bingo or an alternate, friendly airstrip for refueling. Check the Set Waypoint map for other blue airbases between your base and the target. By allowing yourself a return to this bingo base you can carry a bigger weapons delivery payload, but there are drawbacks. Pilots that land at a bingo base will be unavailable to fly other missions until they return to home base, which takes one day; this shouldn't be a problem as long as you rotate your pilots. And if you land at an enemy field, you'll find yourself a POW. So, you'll have to be very careful in choosing to use a bingo field.

To use a bingo airstrip you must define it as another waypoint. First set up your normal flight plan. Then, find your bingo base and select Add Waypoint. Place the new waypoint

Figure 8-8.

Falcon 3.0 combat formations

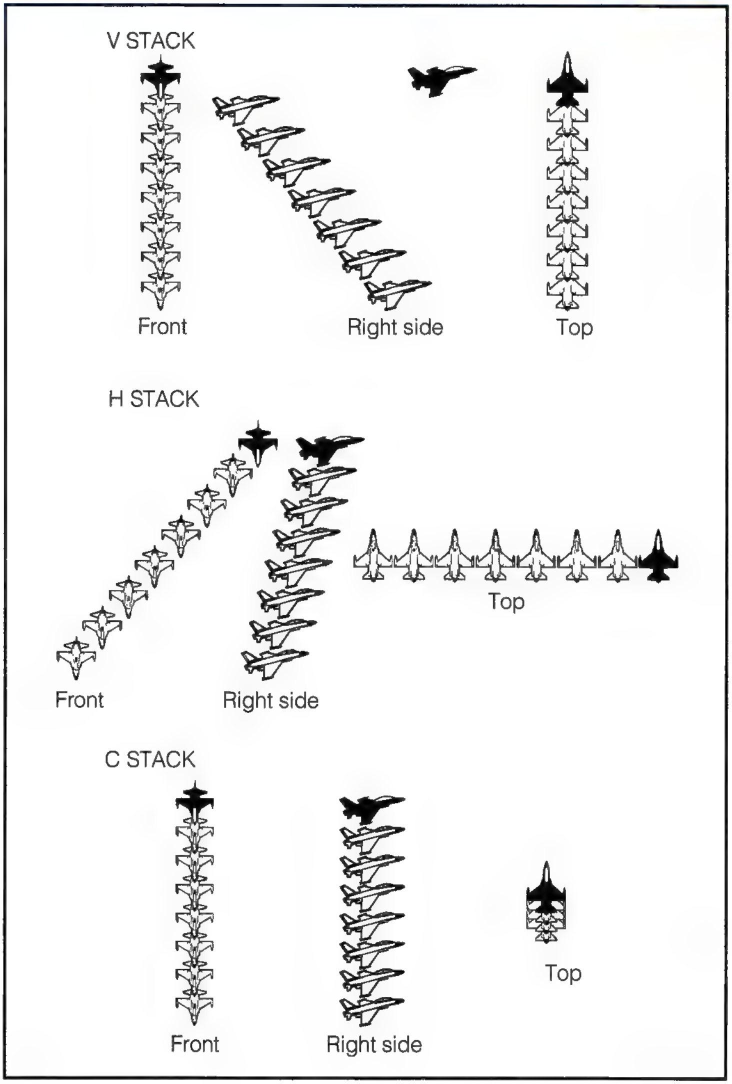
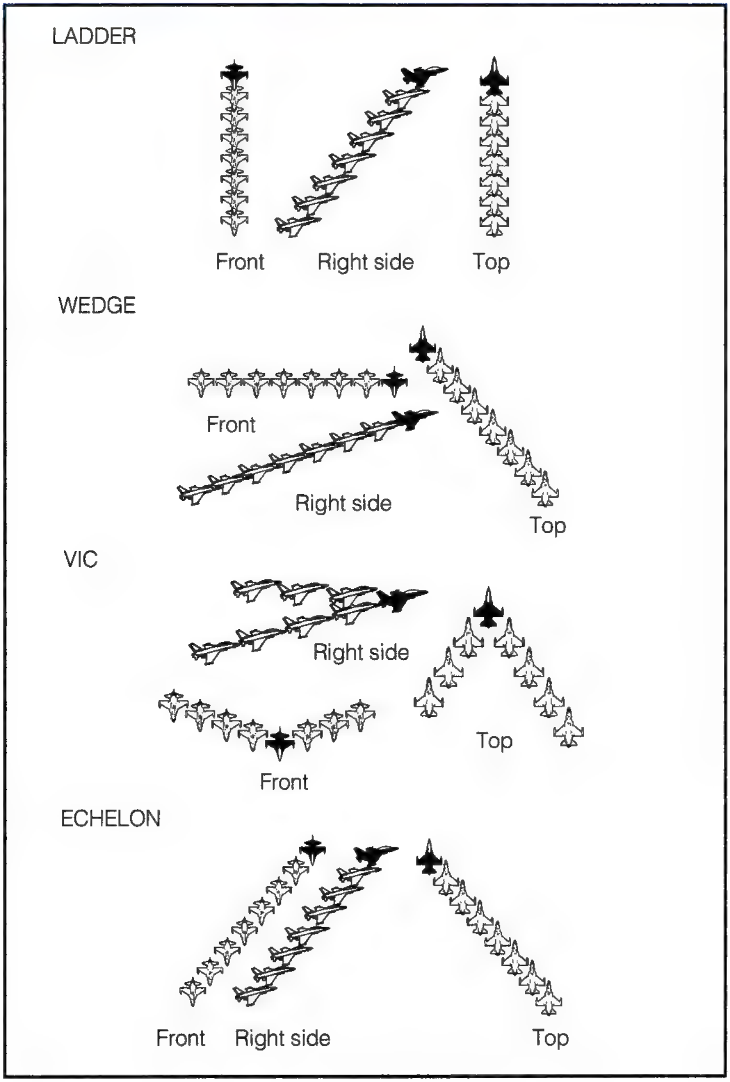


Figure 8-8.

Falcon 3.0 combat formations (continued)



over your bingo field. For example, if you have five waypoints, where 5 represents a landing at your home field, define a new waypoint, making your landing waypoint 6. Take the new 5 and place it over the bingo field. Select Nothing for the action at this waypoint: if you land, your wingmen will land also, and if you get shot down, your wingmen will just head home. Always wait until your wingmen have landed before you select End Mission. Ideally, you should know how much fuel you'll need to get home and whether you have enough; if you're fine, press SHIFT-B to bypass the bingo waypoint.

Ingress Summary

After considering all of these factors you can start to formulate a route into the target area. Remember that SAM sites are an option that can be toggled on and off in the Configuration menu (accessible from the War Room). If SAM sites are on, you will soon discover that you cannot avoid all of the enemy SAM systems and will have to fly near or over some of them in order to accomplish the mission.

Remember to use the "terrain masking" feature in Falcon 3.0 (that is, use the mountains to hide your jet as much as possible). This is not the only way to ingress, but it seems to work best in most cases in Falcon 3.0 and in reality, when ingressing into the target area.

***Note:** The best way to ingress the target area when you have to go within 15 miles of a known SA-6 site is at 500 feet or lower, flying 500 knots.*

Weapons Delivery

The next thing to plan is your weapons delivery. To accomplish this, look at the target's position and plan your attack to maximize your chances of destroying it without getting yourself morted. The simple rules of thumb given in the following sections will help you plan the proper direction from which to attack targets in Falcon 3.0.

Bombing Bridges and Runways

When bombing bridges, make your attack down the length of the bridge. During your attack, fly down the road approaching the bridge, since this will give you a bigger target from six to twelve o'clock, where most Falcon bombing errors occur.

(When dropping bombs in Falcon, you will probably tend to miss the target by dropping either short or long.) The same applies to a Durandal attack on a runway. Approach the runway in the same direction that you would fly if you were landing.

Lining Up Multiple Targets

Always try to line up targets in Falcon so that you can take out more than one in a single pass. The two nuclear reactor towers in the Review 2 lesson in Red Flag are an example of targets that can be lined up. When in doubt about which direction to attack the target, come in from the most direct route that keeps you clear of the enemy.

Waypoints

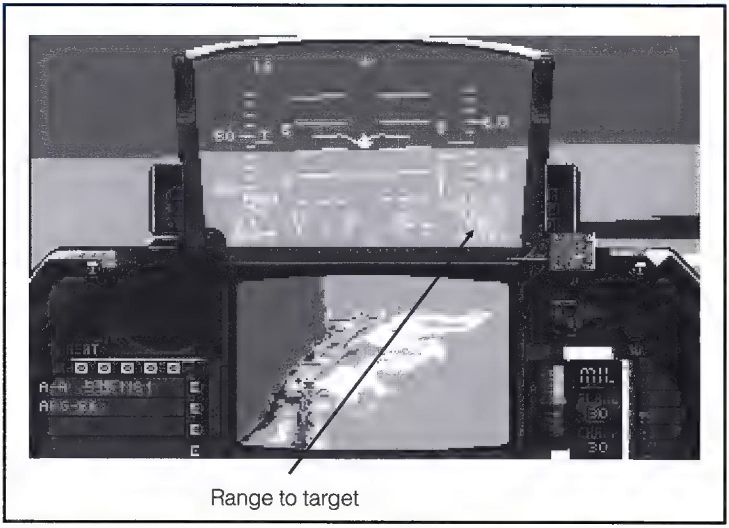
When you select a mission in Falcon 3.0, the latitude and longitude coordinates of the target for that mission are automatically loaded into the Falcon navigation "computer." For every mission in Falcon 3.0 the waypoints for the target will be loaded, and the HUD will display the range to the next waypoint. Figure 8-9 shows the Falcon HUD display with waypoint 3, labeled D3. The range of your aircraft to the target in miles is displayed right beside the waypoint number.

It can be very useful to change waypoints. The best way to use waypoints is to use the automatic range to your target for your attack. After the attack, you can skip to the waypoint for your airfield so your HUD shows a range readout to the base. While the default waypoints in Falcon 3.0 seem to employ a direct approach that may conserve some fuel, they are more likely to get you into premature engagements with the enemy.

Remember to check the Set Waypoints map and pay attention to the position of the target relative to enemy forces or bases. (Use the Zoom view.) Adjust your approach to take any advantage you can based on the position of hostiles, as well as the terrain. You can always ask your AWACS for navigational information by pressing SHIFT-N.

Figure 8-9.

Navigational aids in the F-16A cockpit: waypoint and REO in map mode

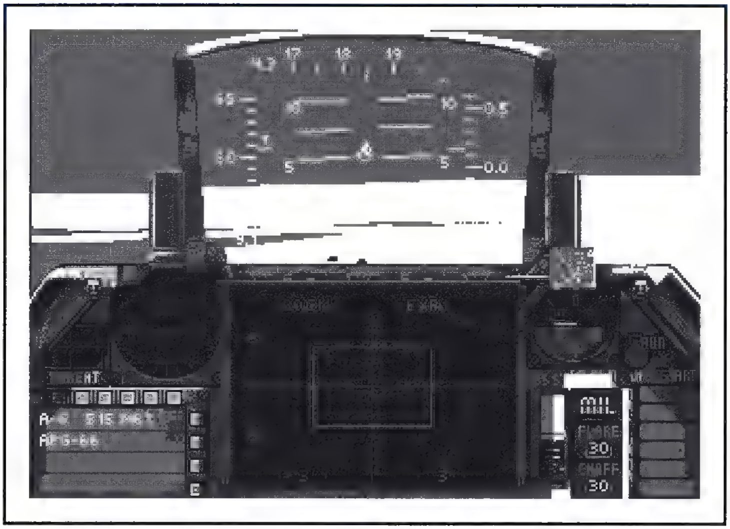


The Pop-Up Attack

The pop-up attack is used in Falcon 3.0 when you approach the target from low altitude. You only need to execute a pop-up to find the target and get lined up. A very low approach to the target will make target acquisition difficult and you may not see the target until you are in too close to make an attack. Popping-up from a low approach may help you get a Maverick shot off at longer range even when the target is easily seen because you will spot the target from farther away as you climb to higher altitude. Execute the attack by approaching the target at low altitude (500 feet). When your range to the target is five miles (as shown by the waypoint display in your HUD) start a five-degree climb as depicted in your HUD in Figure 8-10. Level off between 1,000 and 2,000 feet. When you see the target, line up and start your attack.

Figure 8-10.

Initial 5 degree climb during a pop-up attack



Controlling Your Wingman

You can direct your wingman to execute certain actions during the course of a fight by pressing certain keys. The keys described in the following sections are your available commands.

Basic Wingman Commands

You can order your wingman to take the following actions by pressing the listed key combinations:

- Engage (SHIFT-E)
- Disengage (SHIFT-Q)
- Roll out and fly straight and level (SHIFT-S)
- Maintain radio silence (SHIFT-R)

When you tell a wingman to engage, you are instructing him to enter a turning fight with the closest bandit. (See Figure 8-11.) When you tell a wingman to disengage you are telling him to knock it off.

Break

Break left/right is a maximum *G* turn into an attacking bandit, which will keep the bandit off your back. You would direct your wingman to break if you detected a bandit at six; most likely the bandit's turn radius will not be tight enough to stay on your wingman's six. If your wingman breaks and the bandit follows, you could maneuver onto the bandit's six. See Figure 8-12. Break high/low is the same except that the bandit would be approaching from above or below.

Figure 8-11.

Wingman engaging

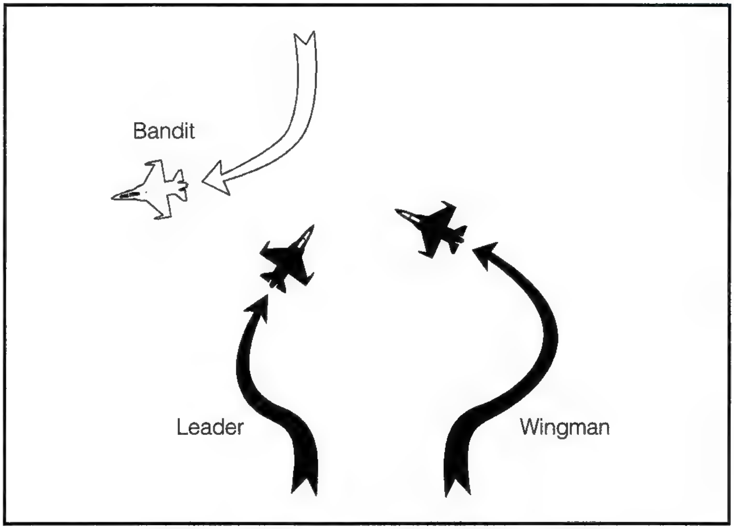
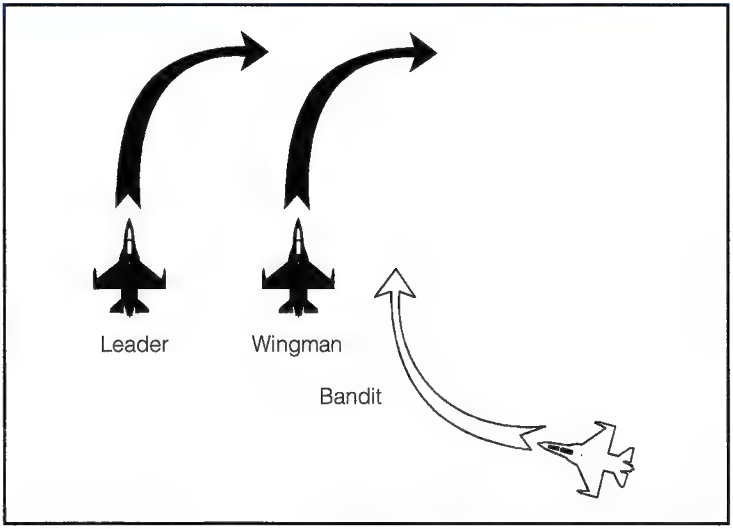


Figure 8-12.

Wingman executing a break turn to the right



The following key commands order your wingman to execute a break maneuver:

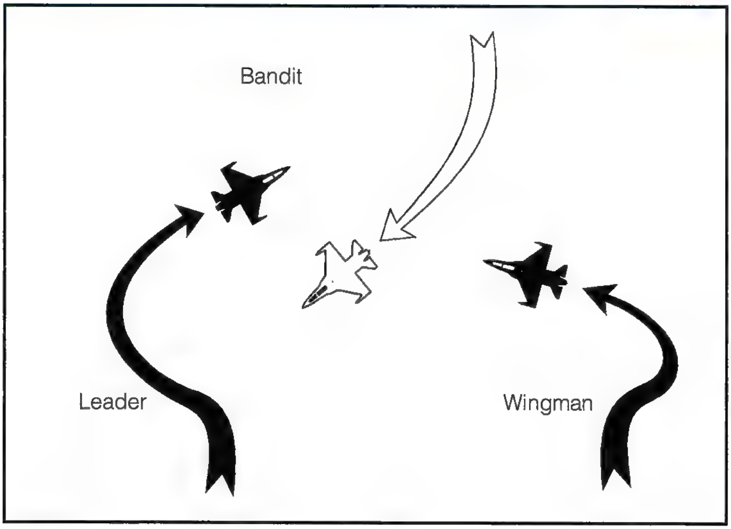
- Break left (SHIFT-A)
- Break right (SHIFT-D)
- Break high (SHIFT-W)
- Break low (SHIFT-X)

Bracket Execute bracket left/right gives the wingman the command to execute a *bracket*, or a *pincer*, to intercept a bandit formation from two sides, so that the bandit is caught between a rock and a hard place. This maneuver is usually executed outside of 15 miles. See Figure 8-13.

The following commands order your wingman to execute a bracket maneuver:

Figure 8-13.

Wingman executing the right arm of a bracket



- Bracket left (SHIFT-X)
- Bracket right (SHIFT-C)

Drag

Drag left/right is also called a *pump*. This maneuver is used to decoy the enemy with a fighter that is leaving the engagement. While the bandit takes the bait, you or another fighter will have a relatively easy shot at the bogey. You must initiate a drag before you get within ten miles of the bandit, or you will open your wingman to an air-to-air missile. See Figure 8-14.

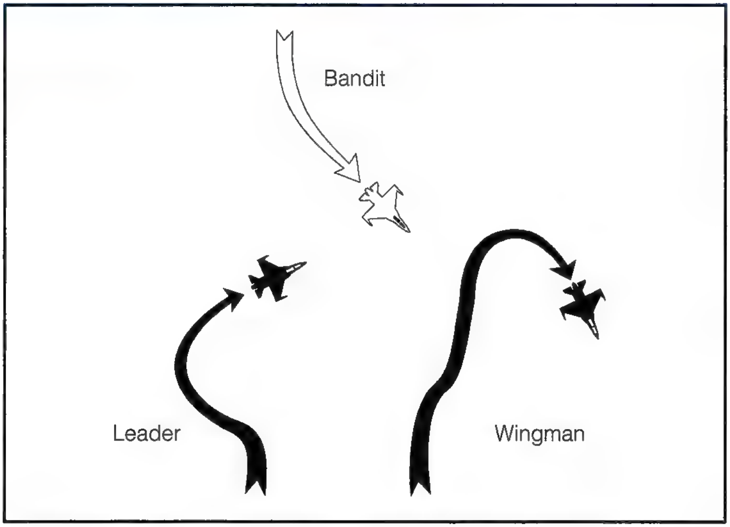
The following key commands order your wingman to execute a drag:

- Drag left (SHIFT-2)
- Drag right (SHIFT-3)

***Note:** Keep in mind when executing a bracket that you will lose visual track of the target unless you go to Padlock view. You should not attempt a bracket if the aspect angle is less than 160 degrees at 20 miles or the bandit will be outside your pincers. In such a case, only one pincer will be in a defensive posture.*

Figure 8-14.

Wingman dragging a bogey to the right



Messages from Your Wingmen

Your wingmen will send you verbal messages, which can tell you any number of things about their condition and your situation. Also, refer to the top line of your display to see the messages displayed. The Falcon 3.0 manual contains a list of wingmen's messages.

Your Voice Message System

Your Voice Message System can give you three audible cues as to the status of your F-16. If you hear "Pull up," your course of action should be self-evident. This means you are approaching terra firma at an alarming rate. "Warning Warning" means there has been a major systems failure onboard your F-16. It's time to reach for the ejection handle (remember to level out first). "Caution Caution" means you should check the caution panel in the right cockpit view.

Egress

A number of pilots may carefully plan how to get into the target area but many of them forget to plan how they are going to get out. Fortunately in Falcon the best way in is also the best way out, and you can usually just reverse your course and fly back to the base. The same planning considerations apply to both ingressing and egressing the target area. Minimize your exposure to the threat by flying low and fast and using terrain where you can.

Emitters—Your Radar and ALQ-119 Jamming Pod

When you plan your attack on the target you must also plan what to do with your emitters. An *emitter* is anything that gives off (emits) energy that can be used by the enemy to find and kill you. Your radar and ALQ-119 jamming pod are the two emitters that must be factored into your mission planning.

The question that you should ask when deciding on how to employ emitting sensors and countermeasures is "Does the emitter do more for me than it does for the enemy?" If the answer to this is yes, then go ahead and turn the emitter on. In Falcon 3.0 you should keep both of these emitters off until they are needed when flying an air-to-ground mission. The jamming pod is toggled off and on by pressing E and the radar can be turned off and on by pressing R. When flying the initial ingress of an air-to-ground mission in Falcon 3.0, neither radar nor the jamming pod assists you more than they help the enemy—so keep them off. However, once the SAMs find you (when you get a missile lock-on indication), turn your pod on. When you exit the target area and SAMs are no longer a factor, turn the pod off.

The radar should be turned off as you ingress the target area until a MiG actually shows up on your Threat Warning Indicator. When you start maneuvering for a kill, turn the radar on. In an air-to-air mission turn the radar on and keep it on in order to find the MiGs.

Note: Having the jamming pod on for too long is like painting "shoot me" on your jet.

A Typical Campaign

Let's put all this together in an example: A friendly armored column has trapped an enemy armored column between themselves and a river. They have requested that TAC air finish them off. You have eight planes available. Here is an example of your campaign planning:

1. You look at the maps, and locate the target east of your airbase.
2. You zoom in until the view becomes a three-dimensional view and you find that the enemy column is huge. This means there are probably mobile SAMs and AAA in abundance.
3. You unzoom the view and check the Strat view. You find an enemy airfield not far to the north and west.
4. Fortunately, the south of the target is clear. Range to the target is fairly short, so you shouldn't need external fuel tanks.
5. Expect heavy air resistance. Also, you're going to need a lot of air-to-ground weapons to do any significant damage to the column.

What do you do?

Option 1

Assign four aircraft to a CAP section and four aircraft to the attack section. Load the CAP aircraft with the best air-to-air (AA) weapons you've got—as many as you can hold. Load each aircraft in the attack section with six Mavericks, two Shrikes, two AIM-9s (just in case), and an ECM (Electronic Countermeasures) pod. Make your approach from the south, and select Search and Destroy (S and D) as the action at the target waypoint.

How This Works

You already know how to define the waypoints so that the AA (Air-to-Air) aircraft reach the target zone prior to the attack aircraft, as discussed in "The Set Waypoints Screen," as well as how to set up a CAP patrol. The four CAP aircraft should be sufficient to keep enemy aircraft out of the region. When the strike aircraft arrive, they are appropriately armed to destroy vehicles with the Mavericks and destroy radar units with the Shrikes. (ECM gear is usually pretty effective against SAMs and AAA, especially before a missile has been launched, so the strike aircraft can roam at will.) By using the S and D (Search and Destroy) option, strike aircraft will roam the target area destroying any hostile units they find. (But don't use S and D when you have a specific building to destroy–use it against armor columns.)

As a variation, you might want to break the CAP section into two smaller sections and set up a CAP position between each airfield and the target zone. This way you are less likely to get all aircraft committed on one front and get an unpleasant surprise from the flank.

Option 2

Assign a section of two aircraft as CAP, loaded with the latest and greatest AA weapons you have available. Set their speed in the waypoint section to be 50 to 75kph faster than the other sections so that they will reach the target first and sweep it clear of enemy fighters. In the Edit Flights screen, define a second section of two escort aircraft and overlay their waypoints exactly on top of the attack section's at the same speed. However, after reaching the target, set up a CAS screen of waypoints. Define the remaining four aircraft as the attack section just as you did in Option 1.

How This Works

Option 2 provides the same basic attack package as Option 1, and the same CAP protection as the variation of Option 1. But

Option 2 also provides air cover for the attack flight while en route. Remember, attack planes are heavily loaded for combat and can't defend themselves without jettisoning their ordnance. If you kill 20 MiGs but don't hit the target, the mission is still recorded as a failure.

Option 3

Define the CAP/escort as you did with either Option 1 or Option 2. Break the attack section into two small sections of two aircraft each. Load the first section with two HARMs, two Shrikes, an ECM pod, two laser-guided bombs, and two AIM-9s. Define the speed in the Set Waypoints screen so that these planes reach the target after the appropriate CAP sections, but before the other attack section. Set the action as S and D. Your players will proceed to destroy SAMs and AAA since most of their weaponry is dedicated to this task. Define the last two-aircraft section with lots of Mavericks, ECM, and anything else you can throw on the wings.

How This Works

With Option 3, you can have any CAS package you prefer, but now you have the ability to deal with the surface-to-air threat. A section of two aircraft can carry a total of eight HARMs, eight Shrikes, and four laser-guided bombs. If all goes well, you could kill ten or more surface-to-air threats from a stand-off range. When the second attack section shows up with a total of a dozen Mavericks and four laser-guided bombs, the result can be devastating to the enemy.

Recap and Review

Factors such as distance and aircraft availability will affect all of these decisions. Each individual mission requires new evaluation and decision making. The decisions are tough ones, and the lives of your pilots depend upon you (but then you didn't make section CO by passing the tough decisions to others).

The following sections list some general rules of thumb for assigning aircraft sections.

Use Multiple Sections of Aircraft

Use multiple sections of two planes each rather than one section of four or six planes. Wingmen tend to stay bunched together (the very definition of wingmen!) and are less effective in a large group. Independent groups of two are more flexible (you can assign flights to cover more area) and utilize the assets of the Falcon more fully.

Always Have a CAP Flight Available

Always have a CAP flight available. This can't be stressed enough. If you have a strike target, make sure there's somebody to keep the fighters off the attack aircraft's back. If you're flying a CAP mission, make sure there's another section of aircraft stationed between you and your base. When you run out of weapons and have to bug out, you want somebody watching your back. Nothing is worse than being on final approach with gear down about to touch the runway when a burst from a MiG cannon grounds you permanently.

Use Defense Suppression Techniques Liberally

SAMs and AAA are deadly. Once they've been eliminated, however, the target is ripe for the picking. You have a generous supply of Shrikes and HARMs: use them.

Use ECM Pods on Aircraft Likely to Be Threatened

Don't forget to use the ECM pods on any aircraft likely to encounter surface-to-air threats. The weight of ECM pods slows down your plane, but if you're in a situation that requires them, you're history if you don't have them. Just remember to turn them off when you're trying to avoid detection.

Orders State Minimum Number of Aircraft Required

Orders from above usually state: "You have been assigned to lead a section of *X* aircraft to do *Y*." These orders state *the* *absolute minimum* number of aircraft required to obtain the goal. Do not be afraid to assign more aircraft to the mission.

Know How Best to Use Your Fighters

You have eight planes available for a given mission, but how do you utilize them? It's not necessary to always assign all eight aircraft. First consider the questions asked in the following sections about the target you are striking.

How Strong Is the Target?

How strong is the target and can two aircraft carry enough ordnance to destroy it? Heavily structured targets may require more weapons than two aircraft can carry to destroy it. While a section of two aircraft with six Mavericks each might be sufficient against an oil refinery or a bridge, an armored column with 40 plus vehicles will require several Mavericks to do any real damage.

How Many Targets Are There?

How many targets are available at a given site on bombing missions? Computer-driven wingmen will follow your lead, and will attack the targets defined in the Set Waypoint screen religiously. When you specify Bomb as an action for a given waypoint, you can only specify a single target (if there are multiple targets) at that point.

Some sites, such as industrial sites, may have two or more factories, multiple bridges, and other high-value targets. You could specify additional Bomb waypoints over the same site, but then you are exposing your aircraft to more enemy defenses.

***Remember:** You never want to fly over a site more than once. If you go sightseeing over the enemy you will die.*

Define Multiple Attack Sections The alternative to specifying additional Bomb waypoints is to define multiple attack sections—perhaps two flights of two aircraft each. Send the first section against one factory, the second section against another factory. Have the different sections approach from different sides to further confuse enemy defenders.

How Well Defended Is the Target?

Targets may have two types of defenses: air cover and surface-to-air weapons (AAA and SAMs). In the Edit Flights menu you may use the Tact and Strat views as well as the Zoom functions, including the Zoom to Target function, to determine the enemy concentration around the target.

Are There Airfields or Enemy Bases Nearby?

The higher the enemy concentration, the more likely you will encounter stiff opposition. Heavily defended targets may need a defense suppression sweep ahead of the attacking aircraft to eliminate SAM and AAA threats. Perhaps a section of two aircraft with HARMs and Shrikes is required to suppress enemy radar installations.

Most targets will have some form of air cover available. Those far from an airbase will still probably have some air cover, even if they're only a couple of lowly MiG-19s.

There Is Strength in Numbers

You can go to Pilot Information and view your personal kills, but you can also go to Squadron Records and know that you are directly responsible for every number on that page. If your squadron has a high number of kills, then *you* have a high number of kills, regardless of your individual record. If your squadron has low kills and many pilots MIA or KIA, then you are losing the war, despite your personal record.

The What Ifs

A good fighter pilot always mentally runs through the what if scenarios prior to takeoff. The kind of what ifs you need to look at in Falcon 3.0 primarily involve the enemy. What if a MiG shows up on your Threat Warning Indicator as you approach the target? What if a SAM fires at you during your attack? What if you are hit by an enemy missile and damaged prior to making your attack? There are literally dozens of what ifs that you must consider in Falcon 3.0. No one could give you the absolute correct course of action for all of these situations because there is no one solution to any specific tactical situation. What works one day in one situation may not be as effective the next day in another situation. But there are some rules of thumb that will help you build a complete tactical perspective of the Falcon battle.

React Immediately

The first rule of thumb is *always react immediately* to a missile lock-on or launch no matter what you are doing.

Bandits Are Better Company Than SAMs

The second rule is that a persistent bandit is generally better for your longevity in Falcon 3.0 than SAMs. For this reason you should use the Threat Warning Indicator to predict when a MiG becomes a dire threat and *then* react to the bandit. (A threat becomes dire when the bandit locks on you. When this occurs, engage and kill using the air-to-air instruction provided in Chapter 6.) Until a bandit locks on, you can keep pressing in to the target area.

If You're Hurt You Can Still Shoot

The third rule is if you are hit by a missile and can still shoot your weapons and control your jet, attack the target if you are inside five miles. Outside this range, the chance of success is very poor. Always expect a bandit to show up at your home field when you are low on gas. A fighter pilot corollary to Murphy's Law says, "fuel need is inversely proportional to fuel in the jet." Remember to defend yourself using the techniques discussed in Chapter 6. There is no need to die with gas in the jet, so defend yourself by flying the jet in Mil power and try to make it to the field when you kill the MiG or escape it.

***Remember:** Campaigns aren't won by going it alone. You need the other pilots to ensure your success. Also, their success is a direct result of your leadership and decision making.*

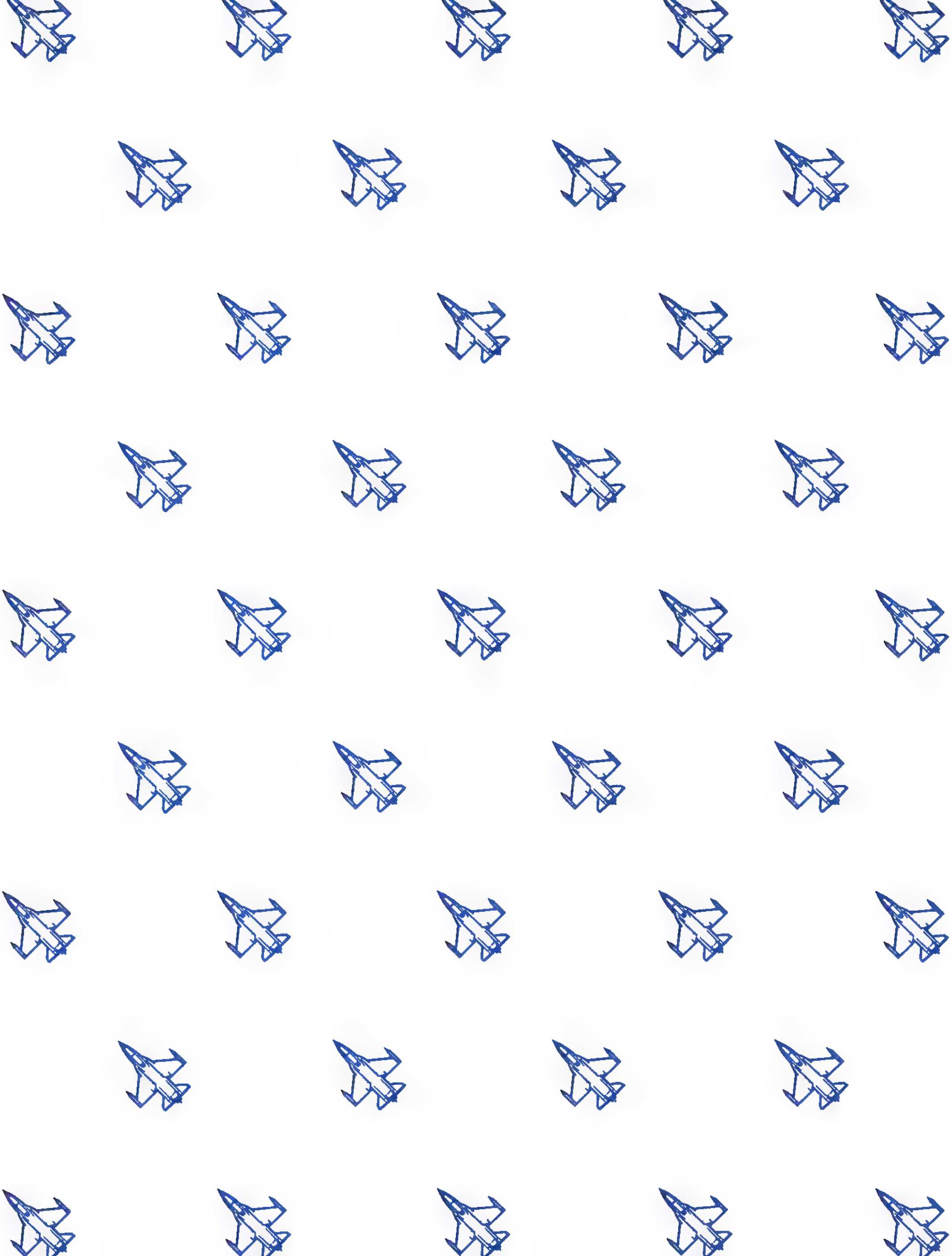
Survival First

The last rule of thumb that will solve most of your what if questions is "think survival first, and target destruction second." This means that you should go after the target like John Wayne would, but if things take a turn for the worse and you find yourself out of airspeed, fuel, and ideas, give peace a chance. Get out of there and go back when things are more in your favor.

Note that none of the techniques and rules of thumb in this chapter, or anywhere else in the book, are etched in stone. The challenge in Falcon 3.0 is to develop your own techniques and style based on your abilities and your perspective of the battle. A story from the book *Lucifer's Hammer* (Jerry Pournelle, Larry Niven [New York: Playboy Press, 1977]), comes to mind when speaking about flying in Falcon and life in general. In the book, a giant comet crashes into the earth somewhere in the Pacific ocean. Several crazy surfers (fighter-pilot types no doubt) realize that a very big tidal wave will crash into California, so they head for the beach to try and catch the wave. When the monstrous wave arrives, a few brave souls actually get up and ride it toward the shore. One surfer rides the wave for a long distance. Finally, a tall building looms in the distance, and he knows he will soon be smashed against it but he rides on thinking "Death inevitable, but if death is inevitable what is left? Style, only style."

No Falcon 3.0 pilot will live forever in the simulation, so what's left is style. Do your best and fly the jet with style. Remember, there's always the ejection handle.

Remember: *When you're heavily loaded with air-to-ground (AG) ordnance you're not going be able to dogfight, and the most trivial adversary becomes a legitimate threat. In such an environment, a flight of CAP or Escort aircraft is appropriate.*



APPENDIX

A

RUNNING FALCON 3.0 ON YOUR COMPUTER

Falcon 3.0 is an incredibly complicated simulation. This appendix gives you information about hardware and software that lets you maximize game play.

Hardware Requirements

IBM or IBM-compatible PCs are the required platform. A hard disk is also necessary. Although it is possible to play the game on a 12MHz (megahertz) 80286 system, a 16MHz 386SX is the recommended "minimum" system. A math coprocessor is required for High Fidelity mode.

Flying Falcon 3.0 on an 80286 system is possible, but it is very slow and hinders game play—all of the graphics and sound requirements of Falcon 3.0 result in a high demand on the CPU (Central Processing Unit), which in turn results in such slow action that screens sometimes look like freeze-frame graphics.

The frame rate on an 80286 machine is slower than that of 80386 and 80486 machines, meaning that fewer frames are processed per second in the 80286 machines. This results in targets appearing to jump around as frames are skipped. If you are using an 80286 machine, be certain to toggle the detail level to minimum.

Software Requirements

You will need 600K, or 614,400 bytes, of free conventional (lower 640K) RAM to install the game, although 620K of RAM is optimal. Additionally, a minimum of 1MB of total system RAM is required. MS (Microsoft) DOS 5.0 or DR (Digital Research) DOS 5.0 or 6.0 are the required operating systems.

Bugs

Not surprisingly, there were a number of bugs in the first release of the game. However, as of this writing, Spectrum

Holobyte has provided earlier users with a *patch* (a program that modifies an original manufacturer's file) that will correct some, but not all, of the bugs in the software. The patch modifies your original FALCON3.EXE file and is available either on disk directly from Spectrum or in the Spectrum Library in the Game Publisher's Forum on CompuServe.

You can tell whether you have the updated software if you see "V3.0C" in the bottom-right corner of the title screen. Version C is the latest release as of this printing; keep in touch with Spectrum to ensure that you receive upgrades.

***Note:** Falcon 3.0B was known to have a virus. By no means should you install Falcon 3.0B on your machine.*

Memory Managers

The first megabyte of your system is divided in the following manner: 0 to 640K is referred to as *conventional* or *low memory;* 640 to 1024K is referred to as *upper memory.* Anything above that first megabyte (1024K) is referred to as *extended memory.* By using a special program called an *expanded memory manager,* the extended memory can be converted into expanded memory, or EMS. Since the majority of DOS programs are unable to address memory in excess of 640K, the EMS manager swaps portions (called *pages*) from the lower sections of memory into the area above the first megabyte, allowing programs to access that memory.

Expanded memory managers also free up conventional memory by loading programs into 384K upper memory. They can copy ROM, such as video ROM, into upper memory, thus substantially speeding up your system. If you use the memory managers that come with either MS-DOS or DR DOS, consult your video card manual. Also, some systems are capable of copying ROM into RAM with a BIOS setting, using their setup utilities. This is referred to as *shadow RAM.*

Falcon 3.0 is programmed to take advantage of expanded memory, when available, for various additional features. (All of the flying for this book was done on systems with 4MB of RAM.) The next sections show what options you can expect to run based upon how much RAM you have configured as expanded memory (EMS).

1MB-RAM Systems

With 1MB of RAM, you will not be able to set up expanded memory. You will have to fly Falcon 3.0 without the benefit of hearing digitized radio messages, and you will not be able to save ACMI videos.

2MB-RAM Systems

With 2MB of RAM, you can configure up to 1MB of EMS. This allows you to hear the digitized voices of your wingmen and the AWACS controller while you're in flight. Additionally, you will be able to load Object data (data for all targets) and Altitude data (data for altitude of terrain) into EMS to cut down on hard disk accesses by Falcon 3.0, which rob you of performance. ACMI videos may be saved, and their length extended by toggling off either of the options (Object data or Altitude data) in the Configuration menu.

3MB-RAM Systems

With 3MB of RAM, you can configure 2MB of EMS. You will be able to load digitized voices, Object and Altitude data, and save ACMI videos.

Systems with More Than 3MB of RAM

If you have more than 3MB of RAM, you will be able to save longer ACMI videos. Also, you can set up some of your EMS to utilize one of various disk caching software programs. Disk caching programs, such as Smartdrive (SMARTDRV.SYS), eliminate frequent hard disk accesses. This increase in performance is most readily seen when making menu selections in the Campaign or Red Flag modes–it reduces the delay encountered in screen selection.

Configuring Your System for Falcon 3.0

Your first mission in Falcon 3.0 should be to configure your system to have the most EMS possible. In the simulation, you bomb targets–but mess up here and you'll bomb your system.

Mission Objectives

- Report to the appropriate section for system configuration
- Note sample listings for the following generic initialization files: CONFIG.SYS and AUTOEXEC.BAT
- Replace any path and/or drive references so that they coincide with those on your system

Initialization Files—CONFIG.SYS and AUTOEXEC.BAT

A CONFIG.SYS file is one of the two initialization files that your computer looks for after loading the operating system. CONFIG.SYS tells the computer which device drivers (such as an expanded memory manager) to load and controls a few other parameters as well. Then your computer looks for the second initialization file: the AUTOEXEC.BAT file. The AUTOEXEC.BAT file tells your computer which programs to load upon start-up, such as a menu program. Like the CONFIG.SYS file, it controls a few other parameters. (It is highly recommended that you read your DOS manual regarding CONFIG.SYS and AUTOEXEC.BAT.)

Take this time to back up your CONFIG.SYS and AUTOEXEC.BAT files to a floppy disk (use a disk drive that can be booted from–usually drive A). After backup, type this command from your hard disk DOS directory: **SYS A:**.

This command will transfer all of the necessary files to your floppy disk and will enable you to reboot from it in case something goes wrong. Additionally, you should back up your

***Note:** Sorry Windows users, but Falcon 3.0 takes up every precious kilobyte of your systems resources. You will be required to fly in uncharted DOS prompt territory.*

AUTOEXEC.BAT and CONFIG.SYS files right on your hard disk. This is easily achieved by copying them to other filenames. An easy way to do this is by copying the CONFIG.SYS file to CONFIG.BAK. Then, copy your AUTOEXEC.BAT file to AUTOEXEC.BAK. Do take the time for this safeguard; there is nothing like ruining your only initialization files.

***Note:** Later in this appendix, you will learn how to manage multiple configuration files and to make a boot disk especially for Falcon 3.0.*

MS-DOS 5.0

MS-DOS 5.0 is the standard system configuration upon which the rest of the configuration outlined in this appendix is based. Upon configuring your system, you should receive 601K free RAM–just barely enough to run the simulation, as Falcon 3.0 will refuse to run with anything less than 600K. MS-DOS 5.0 uses Microsoft's EMM386.EXE to manage expanded memory.

Using a text editor or a word processor that saves in ASCII, create the following files and save them *only after safely backing up your originals.* Be sure to substitute appropriately for each variable (using path names, drive letters, and total memory). For instance, in the following example, the 2048 in the EMM386.EXE line should be substituted (provided that you indeed have 2MB of free RAM to burn). The 1024 in the SMARTDRV.SYS line should be substituted in a similar manner.

***Remember:** Falcon 3.0 requires a lean configuration, so trim out TSR (Terminate and Stay Resident) programs such as appointment reminders. Also, remove device drivers such as those for CD-ROM drives.*

MS-DOS 5.0 CONFIG.SYS Contents

```
DEVICE=C:\DOS\HIMEM.SYS
DEVICE=C:\DOS\EMM386.EXE 2048 RAM FRAME=E000
DEVICE=C:\SMARTDRV.SYS 1024
FILES=30
BUFFERS=6
STACKS=0,0
DOS=HIGH,UMB
```

MS-DOS 5.0 AUTOEXEC.BAT Contents

```
@ECHO OFF
PROMPT $P$G
```

```
PATH=C:\DOS;C:\FALCON3
LOADHIGH C:\MOUSE\MOUSE
```

DR DOS Falcon 3.0 Configuration

The following are samples for files used in Falcon 3.0 with DR DOS 6.0, which uses Digital Research's EMM386.SYS to manage expanded memory. Additional options and improvements to these files may be made by running the Setup program in your DR DOS directory. When properly configured as outlined next, DR DOS 6.0 should give you 614K of free RAM to use with Falcon 3.0.

DR DOS 6.0 CONFIG.SYS Contents

```
HIBUFFERS=15
FILES=20
FCBS=4,4
FASTOPEN=512
HIDOS=ON
DEVICE=C:\DRDOS\EMM386.SYS /F=AUTO /K=2048
/B=FFFF /V /R=AUTO
```

DR DOS 6.0 AUTOEXEC.BAT Contents

```
:DRDOSBEG
@ECHO OFF
PATH=C:\DRDOS;C:\FALCON3
VERIFY OFF
PROMPT $P$G
SUPERPCK /A+ /R:0
:DRDOSEND
```

Memory Managers

The examples so far have been for operating systems. The following three examples are for configuring stand-alone memory managers, such as QEMM, 386 MAX, and NETROOM, to work with MS-DOS 5.0. (Note that these memory managers are not compatible with DR DOS 5.0 or 6.0.)

QEMM386

QEMM386 from Quarterdeck uses QEMM386.EXE to manage expanded memory on your system. The memory analyzer utility that ships with QEMM386 is called Manifest. After running QEMM's Optimize program on the MS-DOS 5.0 initialization files given previously, 620K of the lower 640K of memory was available for Falcon 3.0.

QEMM CONFIG.SYS Contents After Running Optimize

```
DEVICE=C:\QEMM\QEMM386.SYS R:1 RAM ST:F
DEVICE=C:\QEMM\LOADHI.SYS /R:1
C:\DOS\SMARTDRV.SYS 1024
DOS=HIGH
BUFFERS=1
FILES=20
STACKS=0,0
```

QEMM AUTOEXEC.BAT Contents After Running Optimize

```
@ECHO OFF
C:\QEMM\BUFFERS=3
PATH=C:\DOS;C:\FALCON3
PROMPT $P$G
C:\QEMM\LOADHI /R:2 C:\MOUSE\MOUSE
```

386MAX

386MAX from Qualitas uses 386MAX.SYS to manage EMS on your system. It comes with the ASQ 2.0 memory analyzer, which has a complete online tutorial on PC memory and systems in general. 614K of the lower 640K of RAM was made available for Falcon 3.0 using 386 MAX's Maximize utility on the MS-DOS initialization files that were listed earlier in this appendix.

Note: *Be sure to read the documentation for 386MAX thoroughly, as there are several parameters that must be met when running Stacker (see the reference to Stacker in "Making Room on Your Hard Disk," later in this appendix).*

386MAX CONFIG.SYS Contents After Running Maximize

```
DEVICE=C:\386MAX\386MAX.SYS
PRO=C:\386MAX\386MAX.PRO
DOS=HIGH
```

```
DEVICE=C:\386MAX\386LOAD.SYS SIZE=2912
FLEXFRAME PROG=C:\386MAX\
QCACHE.WIN
BUFFERS = 8
FILES = 30
STACKS=0,0
```

386MAX AUTOEXEC.BAT Contents After Running Maximize

```
@ECHO OFF
PROMPT $P$G
PATH=C:\DOS;C:\FALCON34
C:\386MAX\QCACHE /S:1024
C:\386MAX\386LOAD SIZE=28800 FLEXFRAME
PROG=C:\MOUSE\MOUSE
```

NETROOM

NETROOM from Helix software company manages expanded memory on your system with RM386.SYS. Running the Customize function under NETROOM's Discover utility on the MS-DOS initialization files listed earlier in this appendix gave 622K of the lower 640K of RAM to run Falcon 3.0.

NETROOM CONFIG.SYS Contents After Running Customize

```
DEVICE=C:\NETROOM\RM386.SYS AUTO ROM
BIOSHMA=VIDEO
DEVICE=C:\NETROOM\XLOAD.SYS -O
DOS=HIGH
DEVICE=C:\NETROOM\XLOAD.SYS -SB001
C:\DOS\SMARTDRV.SYS 1024
STACKS=0,0
BUFFERS=2
FILES=10
INSTALL=C:\NETROOM\XLOAD.EXE -SF001
C:\NETROOM\DOSUMB.COM
```

NETROOM AUTOEXEC.BAT Contents After Running Customize

```
@ECHO OFF
C:\NETROOM\XLOAD.EXE -SB001
C:\NETROOM\SETCFG.COM -F30 -B30,0
PROMPT $p$g
```

```
PATH=C:\DOS;C:\FALCON3
C:\NETROOM\XLOAD.EXE -SC001 C:\MOUSE\MOUSE
```

The examples given here are for 80386 and 80486 systems. If you have an 80286 system with several megabytes of RAM, you may run QRAM from Quarterdeck or, if you have EMS hardware, 386MAX will optimize your system's memory.

Although the subject of memory management could fill another book, this appendix gives you the minimum you need to know to get you configured and airborne.

Using Your Initialization Files

Now that you have completed the mission objectives, let's see what you can do with the initialization files you've created.

You must use these bare bones configurations each time that you run Falcon 3.0. If you have Windows or some applications running frequently, it may be inconvenient for you to reconfigure your system for a quick session of Falcon 3.0. In such cases you may reconfigure your system by using a bootable disk.

Making a Bootable Disk

You can create a boot disk right from your Falcon 3.0 directory. Spectrum figured that you'd be scraping for memory and tried to make it easy on you. Look in your Falcon 3.0 directory (the default is C:\FALCON3), for .BAT files named BOOT*xx*.BAT that you can use to create boot disks for use with memory managers. Run the particular .BAT file to match your memory manager. For instance, if you are running QEMM, type **BOOTQEMM** from the Falcon 3.0 directory. Have a floppy disk in drive A, and a boot disk will be formatted to load up QEMM and maximize free RAM.

If Your Memory Manager Isn't Listed

If you like the idea of making a boot disk but you have a memory manager other than the one provided with Spectrum's "stock" boot-disk-making batch files, just make the appropriate CONFIG.SYS and AUTOEXEC.BAT files as per the basic guidelines and your DOS or expanded memory manager documentation, and copy them to a floppy disk. Run the SYS A: command from your DOS directory on your hard drive (usually C:\DOS or C:\DRDOS). Now, whenever you wish to fly Falcon 3.0, you need only slip in a disk and reboot.

Flying Without a Boot Disk

If you feel that perhaps finding that special boot disk is a hindrance when the time is right for air combat (that is, your desk is a disaster), then save your Falcon 3.0 initialization files with the extension .F3 on your hard disk, in the root directory (C:\) as follows: CONFIG.F3 and AUTOEXEC.F3. When you wish to fly the simulation (after carefully backing up your originals), follow these steps:

1. Copy CONFIG.F3 to CONFIG.SYS.
2. Copy AUTOEXEC.F3 to AUTOEXEC.BAT.
3. Reboot your system.

When you're finished and you have to crank out that report for your boss in Excel, you can then follow these steps to get your system back the way it was (again, providing that you backed up originally):

1. Copy CONFIG.BAK to CONFIG.SYS.
2. Copy AUTOEXEC.BAK to AUTOEXEC.BAT.

Note: *A batch file (while sounding quite intimidating to the uninitiated) is just a file containing a list of instructions for the computer to run. It is a mini-program consisting of DOS commands. The special batch files provided by Spectrum make disks that, depending upon your software, will allow you to insert the disk, boot up the computer, and fly Falcon 3.0 without messing around with your original initialization files.*

Automating the Configuration Process

This section shows you how to simplify the configuration process by using batch files.

Using your text editor as before, create a file called F3CONFIG.BAT. The contents of F3CONFIG.BAT are as follows:

```
@echo off
echo NOW CONFIGURING SYSTEM FOR FALCON 3.0
pause
copy c:\config.f3 c:\config.sys
copy c:\autoexec.f3 c:\autoexec.bat
cls
echo SEE YOU IN THE AIR, REBOOT SYSTEM:
PRESS CTRL, ALT, DEL
```

To get your system back the way it was, make a batch file called UNFALCON.BAT. The first eight letters are arbitrary—just make sure the extension (the letters after the period) is .BAT.

The contents of UNFALCON.BAT are as follows:

```
@echo off
echo NOW CONFIGURING SYSTEM BACK TO NORMAL
echo FROM FALCON 3.0
pause
copy c:\config.bak c:\config.sys
copy c:\autoexec.bak c:\autoexec.bat
cls
echo BACK TO WORK, REBOOT SYSTEM: PRESS
CTRL, ALT, DEL
```

Making Room on Your Hard Disk

Falcon 3.0 takes up approximately 11MB of hard disk space. This seems to be the trend of the most sophisticated gameware—huge disk space consumption for digitized graphics, speech, and other sound effects.

Stacker 2.0, by Stac, is a real-time data compression utility that can double your hard disk space by compressing and decompressing data for far less than a comparable hard drive would cost. Stacker 2.0 is available with a hardware coprocessor, which minimizes the amount of RAM required to run Stacker. Falcon 3.0 works with Stacker, but Stacker must be loaded into upper memory with a DEVICEHIGH or

DEVICEHI command in your CONFIG.SYS file; therefore, the hardware version of Stacker 2.0 is recommended if you have enough RAM to load Stacker into upper memory. Stacker will then require 14K of base RAM. It is best to use the software version of Stacker with one of the expanded memory managers mentioned earlier (QEMM386, 386MAX, or NETROOM).

***Note:** There is a sound problem if you use QEMM's Stealth feature with Stacker 2.0, so be advised that you may have to disable the Stealth feature if you are using Stacker.*

Getting the Best Performance from Falcon 3.0

Five things will directly affect the performance of your Falcon 3.0 simulation: your processor, computer memory, video system, input device, and whether you have a sound board.

Your Processor

Ideally, you would run Falcon 3.0 on a 486/33MHz (or 486/50MHz) computer, whereby you could choose maximum detail and the High Fidelity flight mode. (The 486 is essentially a fine-tuned 386 plus a 387 math coprocessor.) If you have a 386, a math coprocessor will allow you to run the High Fidelity flight model but a standard 386SX/16MHz system begins to slow when flying in anything but the two lowest detail settings. If you have a 286, then you should fly in the lowest detail setting for maximum performance, which will offer you much less terrain to fly over and generally much less to see.

Memory

As discussed earlier in this appendix, you get more bells and whistles in Falcon if you have 2MB of RAM, and even more RAM is optimal for longer video replays.

Video System

A fast video card is noticeably beneficial; ATI's Wonder XL SVGA board with 1MB of video RAM is one of the fastest (and most economical) SVGA boards available. The ATI 8514 Ultra is a higher end SVGA card and is designed to be utilized as a CAD (Computer Aided Design) accelerator. It has a graphics coprocessor and should run Falcon 3.0 extremely well. A non-interlaced monitor capable of a fast refresh rate (70Hz) should also be considered.

Input Device

Your input device will also affect your gaming experience. Although there are a few game players at Spectrum Holobyte who prefer keyboard control, CH, Kraft, and Thrustmaster Inc., offer alternatives. The Thrustmaster flight control system (composed of the Mark 1 joystick and throttle—see Appendix D) provides a two-handed approach to flying, which puts weapons, radar, and throttle control at your fingertips. CH's Flightstick and Kraft's Thunderstick are both joysticks with a throttle control. With both of these joysticks, you must still use the keyboard to select weapons, change radar modes, and so on. Flightstick and Thunderstick users should note that they may disable their throttle controls, and use the + and − keys on the keyboard instead. For more information, see the command card in the back of this book. (This joystick calibration routine can be accessed during flight by first pressing ESC to bring up the menu bar. Look under the Control menu option, select Joystick, and then choose Recalibrate.)

Sound Board

A sound board helps you to really enjoy Falcon 3.0; with a sound board, voices, sound effects, and music leap out at you. There are several sound boards from which to choose. Some are more fully featured than others, but what is important is their compatibility to AdLib, SoundBlaster, and Roland sound boards.

Most, if not all, sound boards are AdLib-compatible, which means you can enjoy the music and sound effects in Falcon 3.0. AdLib's AdLib Gold and Covox's Sound Master II are both AdLib-compatible. However, none match the Roland MT-32, CM-32L modules and the LAPC sound board for their incredible music synthesis. (But then again, none match their high price either!)

For digitized speech, a CMS SoundBlaster or SoundBlaster-compatible sound board is necessary, such as the excellent

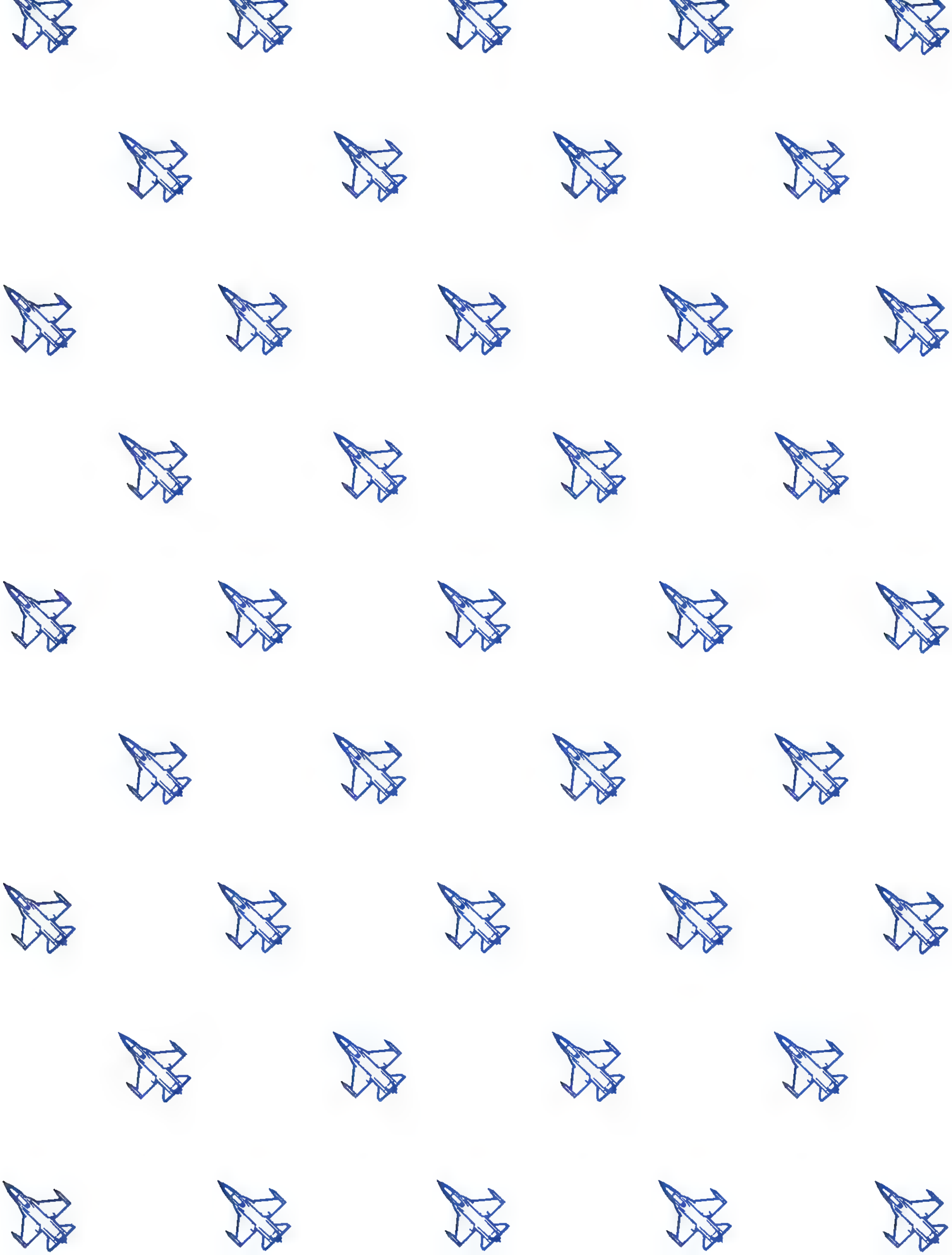
Thunder Board from Media Vision. The SoundBlaster Pro, Media Vision's Pro Audio Spectrum, and the AdLib Gold are high-end sound boards that provide a CD-ROM interface in addition to many other features.

The ATI Stereo F/X sound board is both AdLib- and SoundBlaster-compatible. The VGASTEREO-F/X is an ATI VGAWonder XL video board combined with the ATI Stereo F/X sound board in one card–it even has bus mouse and joystick ports, but you' re locked into a dedicated video/sound card.

Note that the AdLib Gold is not SoundBlaster-compatible, nor is the Pro Audio Spectrum or the Covox Sound Master II (although Covox is working on software to make their sound board SoundBlaster-compatible with certain games, but not Falcon 3.0).

Working Out the Bugs

Spectrum Holobyte routinely fields questions and comments about Falcon 3.0 right on the major computer online services such as CompuServe, GEnie, and Prodigy as well as the standard ways–by telephone and mail. They plan to provide further patches (program revisions) as they become finalized; so hang in there– your reward will be the most comprehensive combat flight and campaign simulator available to civilians.



APPENDIX

B

RED FLAG AND ACMI

As mentioned in Chapter 3, Red Flag is an air combat training program located at Nellis AFB near Reno, Nevada. Pilots from bases all over the country come and fly against the resident Aggressor squadrons who are heavily trained in potential enemies' combat tactics. You may be familiar with the U.S. Navy's equivalent air combat training program run out of Fightertown, California, as seen in the film *Top Gun*.

Red Flag

Red Flag at Nellis is conducted as a mini-campaign, or a series of missions set to run over a specified number of days. ACMI (Air Combat Maneuvering Instrumentation) is a tool used at Red Flag to analyze training missions, much like the time when my (Pete Bonanni's) flight tape showed (to all gathered) that I ended up taking out a bush instead of a tank during a simulated strike. The Falcon 3.0 manual covers the exact procedures used in creating Red Flag missions and viewing ACMI playbacks. The following paragraphs summarize these procedures. ACMI is covered in more detail later in this appendix, in "ACMI."

Falcon 3.0's Red Flag was simulated in Chapters 3 and 4 when you learned the basics of maneuvering and weapons delivery. However, though you cannot create a mini-campaign, you are not limited to just those training missions that come preloaded with Falcon 3.0–you can create your own missions, fly them, record your performance with ACMI like the real Red Flag pilots do, and learn from your mistakes–or share your scenarios and victories with other Falcon 3.0 pilots. In Appendix C, you'll learn how to actually interact with other Falcon 3.0 users as allies and enemies.

Sharing Your Scenarios

One way to share your scenarios and victories is to upload your Red Flag missions and ACMI "tapes" to an on-line service such as CompuServe or GEnie.

On CompuServe, go to either the Flight Simulation Forum or the Modem Games forum and post a message to the Sysop regarding uploading and downloading Falcon 3.0 missions and ACMI tapes.

Keep in mind that when you choose a pilot to fly a Red Flag mission, his skills–dogfighting, bombing, and flying–will be affected. If you do well, the pilot's skills will increase. If you fail, the pilot's scores may drop. This is a good way to work on some pilots' weaknesses before they are shipped off to a Falcon 3.0 campaign.

You can also edit your squadron's attributes by downloading the FALCONER squadron file editor from CompuServe. This is freeware and can be found in CompuServe's Flight Simulation Forum in the Modern Air Combat Library under the name FALCNR.ZIP.

Falcon 3.0 Red Flag

From the War Room, click or choose the Red Flag screen just as you did to fly earlier missions. You can load and modify an existing mission, or choose Clear Mission to create one from scratch. Choosing Nellis Command allows you to define your new mission parameters or edit a preexisting mission.

The procedure for setting up a custom Red Flag mission is very similar to the preflight tactical analysis you did to fly a mission during a campaign. The map will display the area around Nellis AFB where you will conduct your Red Flag training flights. Here you can put down any allied or enemy forces (ground or air) you like, and set your waypoints as well.

ACMI

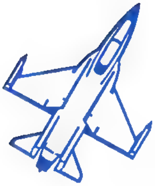
ACMI, or Air Combat Maneuvering Instrumentation, is used at Red Flag to help analyze pilot performance. It is essentially a computer-enhanced video recording of your performance. In Falcon 3.0 you can toggle ACMI on or off from the cockpit by pressing CTRL-R; check your left cockpit view to see the AVTR (Airborne Video Tape Recorder) Status Light and Tape Indicator. The amount of tape left depends on how much EMS memory your computer has; each megabyte will give you about 20 minutes of recording time. Pressing CTRL-S will save the tape to disk and reset the counter. Pressing CTRL-R a second time will toggle the AVTR off and mark the recorded segment with an index; all indexed segments will be combined into one tape at the end of the flight.

ACMI controls are very similar to those of a VCR, with some notable exceptions. You can enter the filename of a replay you saved to disk by pressing TAB to erase the default filename and then entering your own, or by pressing ESC to select a filename from a list of the .VCR files on your disk.

The Replay mode allows you to follow the trail of an aircraft, as if each wing left a trail behind it. A right wing leaves a green trail and a left wing leaves a red trail. Combined with the ALT (Altitude) Line, which draws a line from each plane and missile to the ground, you can watch and analyze each step of your engagement. You can further identify each aircraft's speed and heading along with a numerical altitude reading by selecting the Plane Info button.

Additionally, at any time during the playback you can toggle between wire frame and filled graphics. Wire frame graphics only show a skeletal outline of the aircraft, so you can "see" through it. From the ACMI panel, you can select several external views and set them to follow either of the aircraft automatically. You can also have the viewing perspective move independently of the aircraft. You can switch to a full screen (without the ACMI interface panel) by pressing ENTER. You can get the ACMI interface panel back by pressing ENTER again.

ACMI creates .VCR files on your hard drive. However, files created with Falcon 3.0 are not compatible with those created by Falcon release version 3.0a. Moreover, .VCR files created in High Fidelity flight mode can be viewed only on machines that are equipped with a math coprocessor. For further instructions regarding the use of the ACMI interface, refer to the Falcon 3.0 manual and the *Falcon 3.0 Release Notes and Communications Handbook.*



APPENDIX

C

TAKING ON HUMAN OPPONENTS IN FALCON 3.0

The real challenge of flying the F-16 in Falcon 3.0 begins when you decide to make the jump and fly via modem, null modem (direct link cable), or a local area network (LAN), for all-out dogfights against human opponents. Fighting the enemy pilots that Falcon 3.0 gives you is a cheap thrill compared to going against a real jock on the other end of your telephone line.

Configuring for Modem or LAN Play

In order to fly with or against another pilot, over a modem or LAN, you will need to go to the Comms (Communications) menu. This is accessible from the War Room by clicking on the Comms TV monitor. You will find yourself at the Squadron Transfer menu. Continue by selecting the Comms menu option. This should place you at the Comms menu, which has all the options you need: COM Port selection; Modem, Direct Link, or Local Area Network (LAN); the phone entry line; baud rate; Allied two and multi-player options; and Duel two and multiplayer options.

When using Falcon 3.0's Communications mode, all players must be using the same version of Falcon 3.0 (3.0C or the most recent). If you are using a LAN, it must be compatible with Novell's IPX protocol (refer to the "LAN Walkthrough" section at the end of this appendix for an example of configuring a system with network drivers). In Duel mode be sure that players turn off all SAMs/AAA, as the ECM pod is not effective in Duel Communications mode. If a connection is broken (for example, you forget to disable call waiting) in Duel combat, there is a possibility that squadron data will get corrupted. You should either create a brand-new squadron, or back up your existing squadron when entering head-to-head mode. Your squadron files end with the .SQU extension.

Modems

A *modem* (which stands for modulate/demodulate) is a device that converts computer information to a signal that can be sent over the telephone lines. For Falcon 3.0, the slowest modem that you should use is a 2400-baud modem. Ordinarily, the Falcon 3.0 software alone is sufficient to hook up to another Falcon 3.0 player's modem, but there are certain exceptions.

Modem Walkthrough

Using a modem in Falcon 3.0 is fairly straightforward. If you have an internal modem, make sure that it is jumpered correctly for either COM1 or COM2. Most mice like to have COM1 so your modem will most likely be on COM2. If you have an external modem, plug it into your serial port for COM2 with a serial cable (most computers have a female 9- or 25-pin connector to accommodate this). Be certain that all connections are secure and that the modem is on (if your modem is internal, it is automatically on whenever your computer is on).

Connecting your modem to that of another player while both of you are running the Falcon 3.0 software is merely a question of deciding who will call, who will answer, how to disable call waiting (if applicable), and then meeting in the sky for all-out air combat action. For instance, if you both wanted to hook up at 2400-baud and dogfight each other, you would each select Modem, 2400 baud, and 2 Player Duel from the Comms menu screen. Then one player would call by entering the other's phone number and clicking Accept or Save Settings (the latter saves the settings for future use).

***Note:** At slower baud rates, there is about a three-to-five-minute wait for the dogfight to begin once the connection is established. The wait for Allied missions is approximately five to eight minutes. The programs are passing data back and forth and will display the Satellite Downlink screen. Red dots denote the progress of the data transfer.*

Once the action starts, players may talk to (taunt) one another by using the Chat mode (` key).

Online Services

An excellent place to meet other Falcon 3.0 pilots is through the various online services, such as GEnie, Prodigy, and

CompuServe. The next sections walk you through play of Falcon 3.0 on CompuServe, and tell you how to utilize the gaming features unique to this online service. For information regarding play of Falcon 3.0 on other online services, contact your respective Systems Operator (SYSOP).

CompuServe

CompuServe has a Flight Simulation Forum (GO FSFORUM) where you can discuss Falcon 3.0 with jocks from all over the world. There is also the Modem Games Forum (GO MODEMGAMES) where you can post challenges to take on aerial foes.

The Modem Games Forum and the Flight Sim Forum differ. While there is some crossover, most challenges are in the Modem Games Forum, and most discussions on game play and tactics are in the Flight Sim Forum.

Playing Falcon 3.0 Via CompuServe

The following steps will allow you to play Falcon 3.0 via a CompuServe connection:

1. Log on to CompuServe using the following communications software: PC3 by CompuServe, PROCOMM by Datastorm Technologies, or one of the other communications packages documented in "Communications Program Criteria" under the menu choice entitled "What Is Online MTM Gaming" (GOMODEM).
2. Meet your opponent in the MTM Gaming Lobby (GO MTMLOBBY). If you do not have an opponent, use the MTM Challenge Board to locate an opponent (GO CHALLENGE) and use the Modem Games Forum (GO MODEMGAMES) or CompuServe Mail (GO MAIL) to schedule a match.
3. Once in the Lobby, type **/USERS** to get a list of other players in the Lobby. Type **/HELP** to get more assistance with the Lobby commands.

4. Designate your game as Falcon 3.0 by typing **/GAME FALCON 3.0** (or **FALCON 3**). To clear this game title, type **/GAME** by itself. Pair up with your opponent by typing **/CHALLENGE # FALCON 3.0** (or **FALCON 3**) (where # is the player number of your opponent). Your opponent accepts the challenge by typing **/ACCEPT #** (where # is your number).

5. Exit your communications software after you have received the following two messages from the Lobby:

   > Switch to FALCON 3.0 (or FALCON 3) when connected. . .
   >
   > Connected to [connection ID]

   To exit, follow these commands:

   - PC3 Users: Press F10.
   - PROCOMM Users: Press ALT-X.
   - Crosstalk Users: Press ALT-Q.

6. Change to the drive and directory containing Falcon 3.0 and run the game.

7. After the program loads, you will see the intro sequence and splash screens with the credits. When you are in the War Room, load an active squadron by clicking on the Squadron monitor and then select the Comms monitor. Following this you will have the option of entering either Pilot Transfer or the Comms menu. When you reach the Comms menu, you will see several options, one of which is Direct.

8. Select the Direct menu option and either Duel or Allied modes of play. One player (decided beforehand) should select Call, and the other player should select Answer.

Note: *Do not use Exit to DOS Shell as FALCON 3.0 is too large a program to load within the shell.*

***Note:** The caller is the only one who can abort or end the mission, so if you need to quit, give him or her a holler using the Chat mode (`key). Additionally, the theater will be whatever the caller selects.*

9. Once the connection is detected, the program will bring you to the Satellite Downlink screen where you'll see a series of red dots filling in a pattern. How much time elapses before you are in the cockpit is dependent upon whether you chose Allied or Duel. If you do choose the Allied option you will have to wait a little longer for initialization.
10. After the initialization sequence, you will be in the air approaching your modem opponent and (hopefully) setting up for a first pass.

Ending a Match on CompuServe

Upon completion of your match, either by victory or defeat, you will find yourself in the War Room. You'll see this on the screen:

Do You Want to Play Again?

Y/N

If you decide it's time to quit, select N and you will be at the main Falcon 3.0 menu; however, you will still be connected to your opponent through CompuServe. Follow these steps:

1. Select Exit.
2. Restart your communications software and go into terminal mode.
   - PC3 users: Choose Online.
   - Crosstalk users: Choose Direct at the appropriate baud rate.
   - PROCOMM users: Press ENTER.

Upon entering terminal emulation mode, your PC will be able to reestablish your existing connection with CompuServe.

3. Send a BREAK sequence through your communications package to CompuServe.

   - PROCOMM users: Press ALT-B
   - PC3 users: Press ALT-B
   - Crosstalk users: Press ALT-B

   In response, CompuServe will display the following prompt:

   ```
   >> NET CMD MODE <<
   >>
   ```

   Upon receiving this prompt, type the characters **LG** to reenter the MTM Gaming Lobby. Note that the LG command is not echoed back to your screen. When you have successfully entered the LG command, CompuServe will display the following:

   ```
   >> EXIT <<
   ```

   Returning to the lobby, enter **/HELP** for assistance.

4. You are now back in the MTM Gaming Lobby and can debrief your opponent or pick another opponent if you wish.

Finding Opponents

You can find an opponent either by loitering around the MTM Lobby or by scheduling a meeting. One quick way to schedule a meeting is to issue a challenge on the Challenge Board (GO CHALLENGE), explained next. This Challenge Board is a classified area on CompuServe that will allow you to search a database of Falcon 3.0 players in your area code and send challenge messages directly to your would-be opponent's electronic mail box on CompuServe. The other way to find opponents is to post challenges in the Modem Games Forum in the Flight Sims and Games section, or the Flight Simulation Forum in the Modem Air Combat section.

Null Modems

A *null modem* is a special cable that can be hooked up between two computers through their serial ports. Since no signal conversion takes place, data transfer speeds are much higher than with regular modems.

Null Modem Walkthrough

Null modems are great providing that you have a spare machine. If so, null modems are cheap, and dogfighting a buddy in the next room with linked up computers is a blast!

Connect each end of the cable to a serial port (preferably COM2 if mice are being used). Then, repeat the procedure for a regular modem connection. The difference is that you will both select a higher baud rate (9600 is sufficient) and Direct instead of Modem. Remember that one player must select Call and the other must select Answer. The fight's on!

Also, as long as your null modems are hooked up and you are running the terminal emulator program, you can exit that program without disconnecting. Once in the Comms menu screen, since there is already a connection established, you would select Direct and then meet in the sky.

Note: *By using a terminal emulator such as PROCOMM Plus, it is possible to establish a direct connection using two modems, but a null modem connection is the way to go when the computers are in close proximity.*

Establishing Modem Connection Without Terminal Emulation

You can actually establish a modem connection directly between two PCs without terminal emulation software. Here's an example.

Player one has created an ASCII text file called CALL.TXT containing the modem dial command and the opponent's phone number:

```
ATDT 1 555 555 5555
```

Player two has created an ASCII text file called ANSWER.TXT containing the modem answer command ATA.

Player one types the following: **TYPE CALL.TXT > COM2** (or the appropriate COM port for player two's modem). When player two hears a ring he or she should type **TYPE ANSWER.TXT > COM2**, a modem connection is established, and he or she may now begin to run Falcon 3.0. Select Direct in the Comms menu to engage in a Duel or Allied mission. Ordinarily, this procedure is unnecessary, but if Falcon 3.0 does not work with your modem, this may solve the problem.

Note: *After selecting Modem from the Comms screen, you are given the option of entering your own modem initialization strings. You should read the appropriate section of the manual that came with your modem for more details.*

LANs

A LAN, or Local Area Network, is simply several computers that are linked together with special adaptors. LANs are capable of high-speed data transfer and share a common drive on one particular computer, which is referred to as the *file server* or simply *server*. LANs are the most efficient way for personal computers to communicate with each other. A LAN is required for more than two players to use Falcon 3.0.

LAN Walkthrough

Falcon 3.0 is the first PC-based flight simulator to include multiplayer support via a network (LAN). The possibilities are very exciting. Imagine flying a mission with five other human pilots simultaneously. Imagine joint missions with human-controlled A-10s and AH-64s (you'll be able to in the upcoming Electronic Battlefield Series simulations from Spectrum HoloByte). Imagine blowing your boss' F-16 to bits with an AIM-9M!

Here are several requirements (other than the minimum requirements for the single player) to keep in mind when setting up a network session:

- You need a Novell Netware Network Operating System such as Netware 386 version 3.11, 3.0, or Netware version 2.2, Advanced 2.15, or Netware Lite.
- Make sure you have the latest drivers and shells. At this time, the DOS shell is at version 3.22a and IPX is at version 3.10.
- You need at least 2MB of RAM, as the network drivers have to be loaded into the high memory area and DOS has to be loaded high. 4MB of RAM is highly recommended.
- All players must be logged into the same file server.
- All computers have to be on the same segment. Falcon 3.0 will not recognize players logged into the file server on a different segment via an internal or external bridge, or a router.
- Falcon 3.0 should be installed on a local hard drive on each workstation. Falcon 3.0 reads a tremendous amount of information from the hard disk when running. This would create a massive traffic jam on the network if the program files were located on the file server hard disk.
- All players must have the same version or revision of Falcon 3.0.

As Falcon 3.0 requires at least 600K of free RAM and an additional 2MB of EMS for sounds and ACMI, loading your network drivers and having enough RAM leftover can be a headache (see Appendix A for more details). Third-party memory managers, such as QEMM, 386Max, or NETROOM, are well worth their asking price and go a long way in helping you configure any PC to run Falcon 3.0 in network mode.

It is important to make sure the network drivers fit in upper memory—the 384K of memory between lower 640K and the first MB of RAM—before you load any mouse drivers or software caches. If you're using a Microsoft mouse driver, version 8.10 allows you to load most of the driver either in EMS (/E parameter) or upper memory (/U parameter). In the configuration given earlier, only a 6KB stub is left in high memory while the rest was loaded into EMS memory. If you are using ODI drivers, and you're low on memory, you can save about 8KB of memory by using this parameter when loading IPXODI.COM:

```
C:\NET> IPXODI A
```

The A parameter loads IPX only and leaves out the SPX and diagnostics responder, which are not required by Falcon 3.0.

This parameter also works when loading the driver into high memory with QEMM's LOADHI or MS-DOS 5.0's LOADHIGH commands. You've now cleared your first hurdle: you've managed to load your network drivers high and have at least 600K of free base memory. The next step is to access the network by typing: **F:\LOGIN> login Ivan.** (Substitute your name for "Ivan.")

Every player needs to log in to the same file server. If your network has more than one file server, make sure everyone logs in to the same server by typing the following instead: **F:\LOGIN> login mainserver/Ivan.**

***Remember:** Replace "mainserver" with the name of your file server and "Ivan" with your login name.*

Make sure that your network login script does *not* load any TSR (Terminate and Stay Resident) programs into memory. If your default login script loads any TSR programs, you can create a special script file for use with Falcon 3.0. This file should be a regular ASCII file and can be in a public directory on the file server hard disk. You can create this script by logging in and changing to the directory you want this file to be in. This is usually a directory named LOGIN. Type the following:

```
F:\LOGIN> copy con falcon3
exit
^Z
```

Use F6 to generate the above ^Z character. After the file is created, log out, reboot, and log in with a command like this:

```
F:\LOGIN> login /Sfalcon3 mainserver/Ivan
```

If you're comfortable writing batch files (see Appendix A) and changing your default login script, you could write a batch file to set an environment variable, load the network drivers, and log in to the network. Your default login script should be changed to check this environment variable before loading the TSR programs. Your network administrator should be able to help you with these changes.

Start Falcon 3.0 as you would normally. If you're planning to play in Duel mode, turn off SAMs in the Difficulty Levels setup screen. Otherwise, you'll be too busy trying to shake SAMs while your buddy lines up on your six.

Proceed to the Communications Setup screen as you would in modem or direct connect play. Select Network as the connection type and select the game type. On a network, you can set a baud rate of up to 57,600. There are several reasons why you wouldn't necessarily want to set it to the highest rate:

- In network mode, the *baud* rate is actually the *data* rate. This means the setting indicates the *amount* of data being transmitted through the network rather than the speed of the data being sent to the other PCs. In network mode, *baud rate* should be correctly interpreted as *data rate.*
- The computers involved are slower 80386 PCs. Running at a fast data rate will result in lower frame rates as the CPU has to send out and keep track of more information per second.
- When you have multiple computers sending data at a data rate of 57,600, your network traffic will remain very heavy throughout your playing session. Other users of your network who are trying to do some *real* work might really get upset!

The faster the baud rate, the less your opponent's plane will *jump* around, especially when you're in guns range. A data rate of 19,200 will give you a fairly smooth frame rate and low jump factor. A faster setting will speed up the *sync* process, affectionately known as the red dots syndrome. All players must select the same data rate. Experimentation will lead you to the best compromise for your network.

Decide on one *caller*, or the squadron leader in Allied modes. Everyone else should now select Answer mode and click on Accept. When all Answer mode CPUs are ready, they will display a box on the screen which says, "Waiting to connect." Now the caller should select Call mode and click on Accept. The caller's PC will now display "Looking for players. Please hold on." while it searches the network. When the caller finds an *answerer*, that answerer's screen will show, "A master computer has spotted you." After a couple of seconds, the caller will display a list of answerers that it has found, showing the login names of the other players.

The caller selects players from the displayed list by using the arrow keys, followed by the ENTER key. After selecting an answerer, the caller will see "Waiting for other side to connect." The answerer will then see this: "Do you wish to play Falcon with Ivan?" (assuming Ivan is the caller.) If you're in two-player mode, as soon as the answerer responds *yes*, both caller and answerer will see, "Falcon session established." Both players will then see the sync screen which says, "In multi-player mode," the caller will return to the answerer list, and an asterisk will appear beside the name of the answerer who has accepted the invitation. You can then select other players in turn. When you're done selecting all the players, select Exit, and the multi-player session is established.

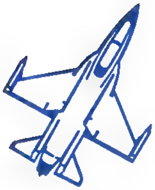
Everything from this point on is identical to modem or direct connect play, as discussed previously. In communication modes, there are several other items to take note of:

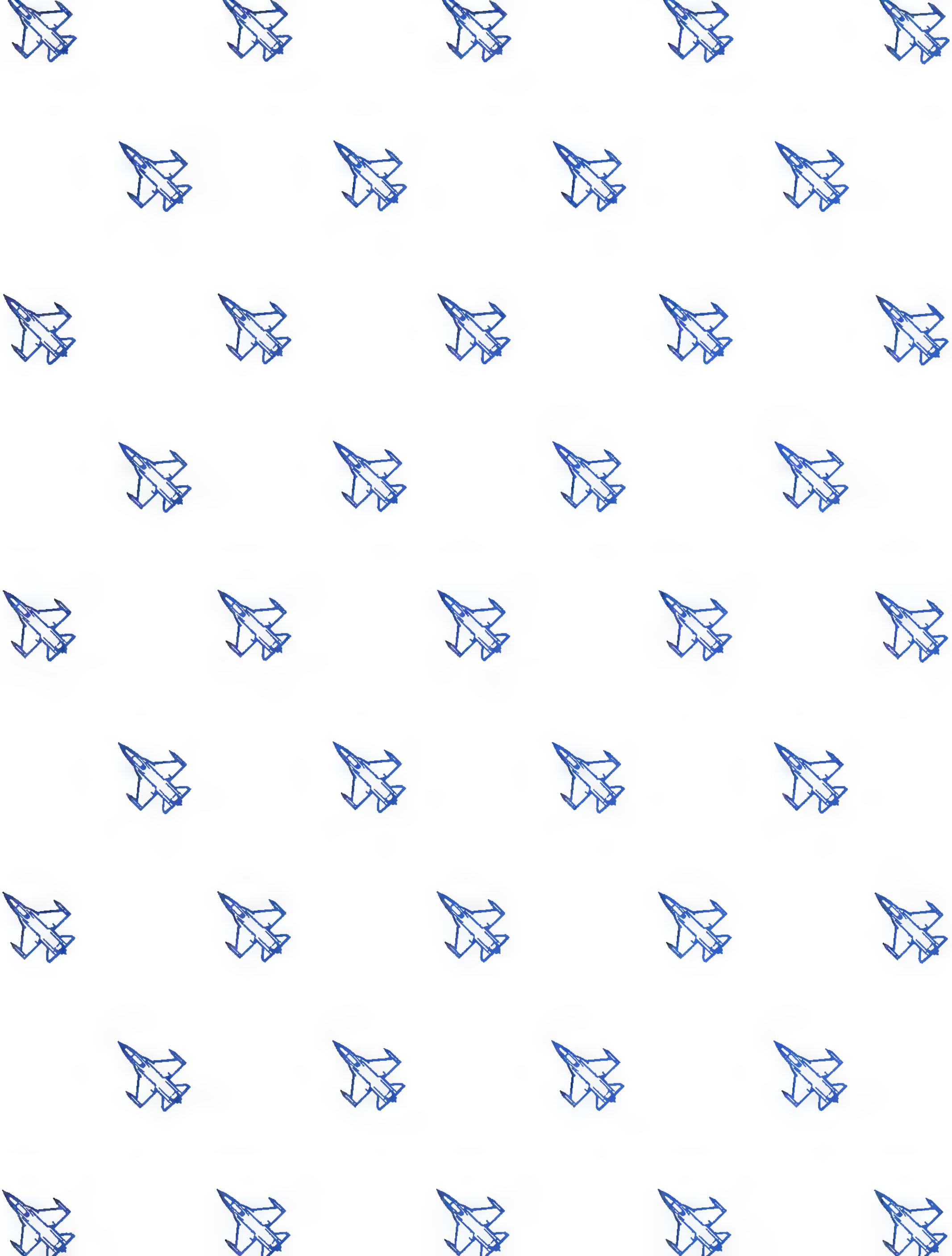
- The caller makes all mission decisions in Allied mode.
- The caller chooses the theater in Allied mode.

- The caller's settings in the Difficulty Levels section are transferred to all answerers' PCs.
- The caller starts on the ground, while all answerers start in the air. Answerers should circle the runway till the caller, and squadron leader, is in the air.
- Only the caller can end a mission by pressing ALT-Q.
- Only the caller can pause the mission. Use the Chat mode (the ` key) to notify your opponent if you need to pause to pick up the phone, answer the door, or do something else.
- The accelerated mode (TAB and SHIFT-TAB) is disabled.
- The menu bar is disabled.
- ECM is disabled in Duel mode.
- The AVTR for ACMI is disabled.

For more information on expanded memory managers and Falcon 3.0, please refer to Appendix A. For configuring IPX and NETX with your expanded memory manager, refer to the documentation that accompanied your software.

If you need further instructions regarding the use of Falcon 3.0 Communications, refer to the Falcon 3.0 manual and the *Falcon 3.0 Release Notes and Communications Handbook*.





APPENDIX

D

THRUSTMASTER'S THROTTLE AND STICK

The Falcon 3.0 simulation requires you to use virtually every key on the keyboard. Unless you are a touch typist, you may find that while you are searching for the proper key, you get blown out of the sky.

Keyboard users at least can use both hands–joystick users must issue all of the keyboard commands with *one* hand. (You would not want to let go of your stick and hunt and peck for the correct keys while trying to evade a SAM.)

Although several flight simulation accoutrements are available for use with Falcon 3.0, only Thrustmaster's Mark I Weapons Control System (WCS) and Mark I Flight Control System (FCS) are discussed in this appendix. These are by far the best accessories available to date for enhancing your play and performance in Falcon 3.0.

Thrustmaster, Inc. has developed devices that let you interact with your simulated F-16 the way real F-16 pilots interact with their vehicles. In a real F-16, many of the functions–such as radar mode and weapons select–are located on the stick and throttle. This is referred to as *HOTAS* (Hands On Throttle And Stick). HOTAS allows F-16 pilots to control several functions without having to take their hands off of the controls.

Mark 1 Weapons Control System Throttle

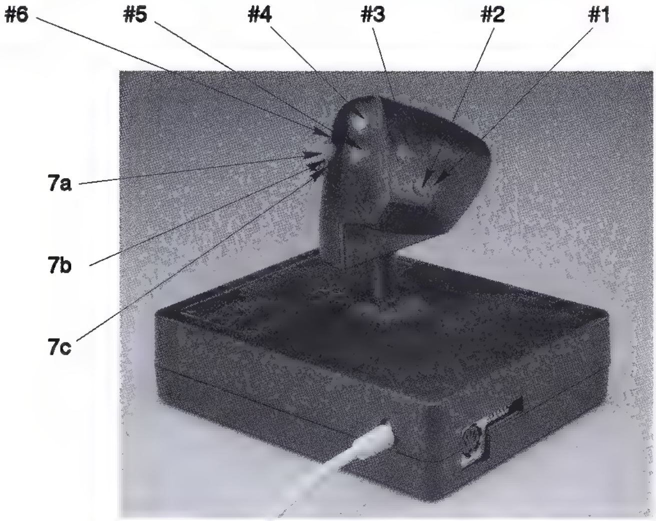
One half of the Thrustmaster system for the Falcon 3.0 pilot–the Mark I Weapons Control System–consists of a throttle device with six buttons and one rocker switch, as shown in Figure D-1.

How to Use It

The Mark I Weapons Control System (WCS) lets you control the throttle setting by moving the handle back and forth. The six buttons let you switch between ACM, NAM, and GM radar modes (via one three-setting button), deploy chaff, deploy

Figure D-1.

The Mark I Weapons Control System



Dip Switch 1 and 6 (Spectrum Holobyte Falcon 3.0)

Switch	Function	Function	Function
1	Flare	Flare	Zoom in
2	Chaff	Chaff	Zoom out
3	Target select	Target select	Target select
4	Clear lock	Clear lock	Clear lock
5	Target lock	Target lock	Target lock
6	Air brake	Air brake	Air brake
7a	on (ACM)		
7b	....	on (NAM)	
7c	....	....	on (GM)

flares, select target, lock target, clear lock, and deploy air brakes.

How It Works

The WCS works by using the combination of a keyboard EPROM (Erasable Programmable Read Only Memory) chip and dip switch settings for use with different flight simulators. When you push a button on the Mark I WCS, you are actually using a keyboard emulator that sends the same scan code to the program that you would send by pressing a key on your computer's keyboard. Therefore, you would not want to have the Thrustmaster WCS active when you are not flying Falcon 3.0 as unpredictable keyboard commands will be generated.

Upgrading the WCS Chip

At this point, the Mark I WCS is non-user configurable and you must send away to Thrustmaster, Inc. for replacement EPROM chips. The upgrade chips are available every January and June. However, some work is being done with TSR programs that may allow you to configure the WCS buttons to your liking.

Mark 1 Flight Control System Joystick

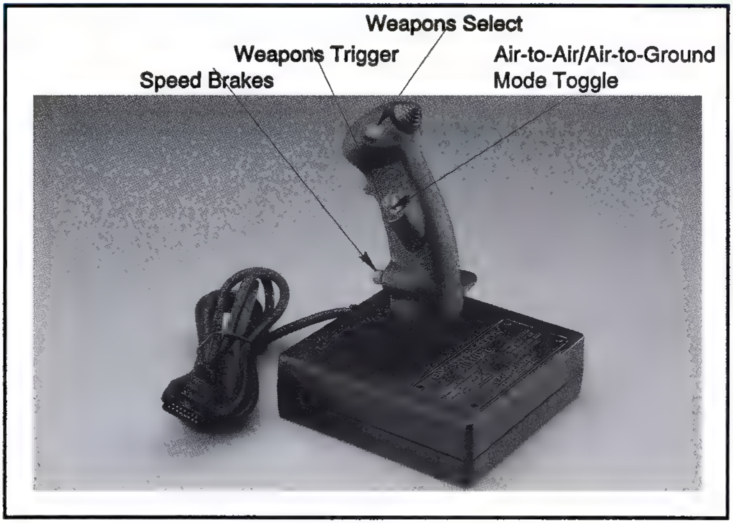
Thrustmaster, Inc. also puts out the Mark I Flight Control System (FCS) joystick, which is modeled after the joystick from the F-4 Phantom (see Figure D-2).

Falcon 3.0 was programmed to take advantage of the buttons on the FCS joystick, which control the following functions: Speed Brakes, Air to Air/Air to Ground weapons/HUD mode select, weapons cycling, and weapons firing. Since the FCS joystick and WCS throttle are modeled after real flight hardware (in a real F-16, the joystick is on the right and the throttle is on the left), the FCS joystick is right-handed, and the WCS throttle is left-handed.

To climb with the FCS joystick, pull back (referred to as applying backpressure to the stick). Diving is achieved by pushing foward on the stick, while rolling is achieved by

Figure D-2.

The Mark I Flight Control System



moving the stick from side to side. If you roll approximately 30° from wings level and then apply backpressure, you will perform a bank turn.

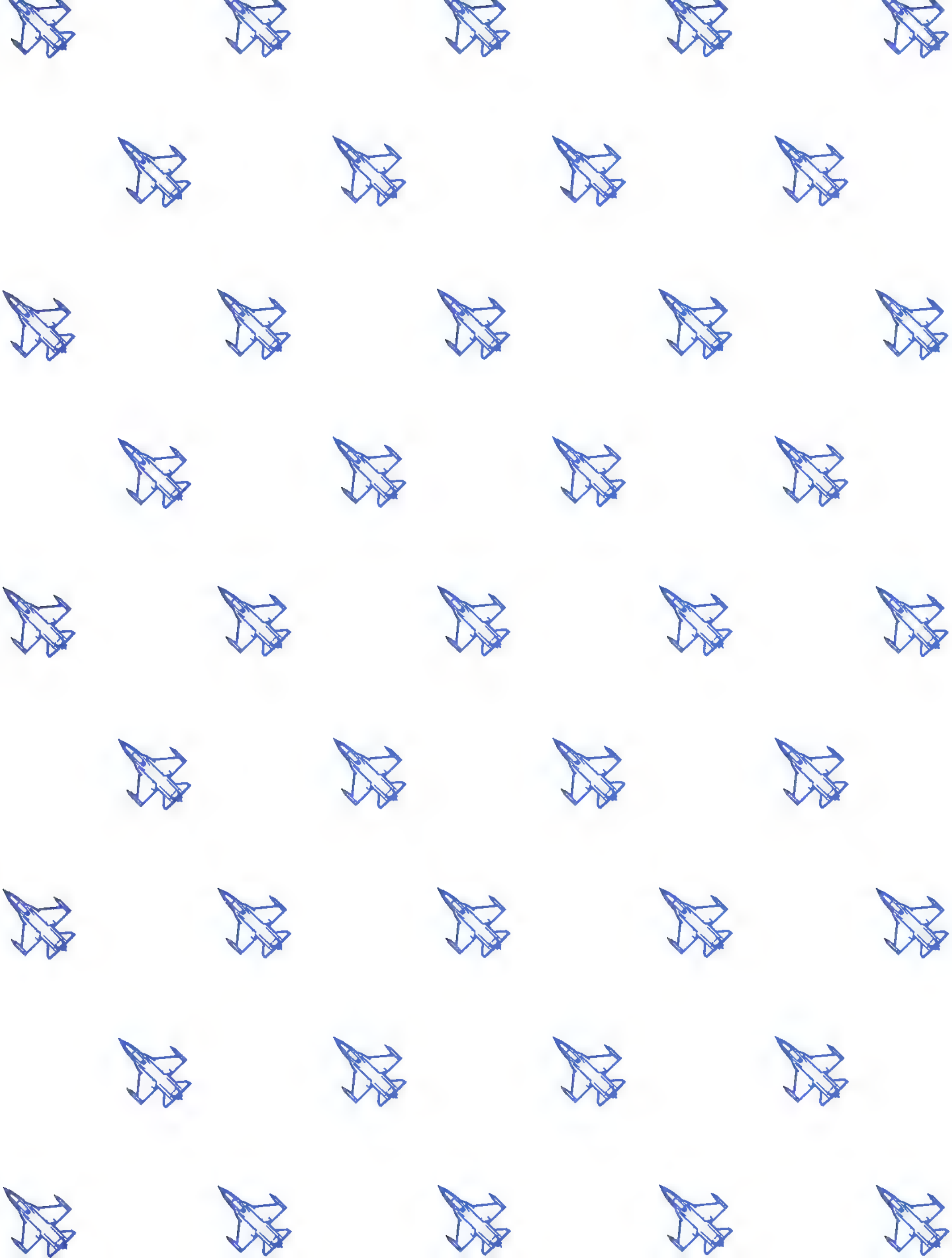
During a Within Visual Range (WVR) dogfight, you can control your aircraft without touching the keyboard. This helps keep your SA (Situational Awareness) focused, and lets you concentrate on the enemy aircraft rather than on the keyboard.

For more information regarding the Thrustmaster HOTAS system, see the Falcon 3.0 manual or contact Thrustmaster, Inc. at the following address:

Thrustmaster, Inc.
705 SW Ellis
Lake Oswego, OR 97034

Voice (503) 697-3200
FAX (503) 635-5528

***Remember:** "Lose sight, lose the fight." If you have to look down at your keyboard repeatedly, you will have a more difficult time in a dogfight than you would if you could maintain continuous visual contact with your target.*



APPENDIX

E

GLOSSARY

The following is a glossary of official terms and slang used in Falcon 3.0.

AA Air-to-air missile (such as the AIM-9).

AAA Anti-aircraft artillery.

AB *See* Afterburner.

ACM Air combat maneuvers; usually two versus one.

ACMI Air Combat Maneuvering Instrumentation; used with AVTR (Airborne Video Tape Recorder) to review your performance at Nellis AFB.

ACT Air combat training; usually two versus two.

AFB Air Force base. A major administrative center. (By contrast, an Air Base is a small facility with few support buildings.)

Afterburner A section of the jet engine that the pilot can select using the throttle. When selected, fuel is dumped into the aft end of the engine and ignited, giving the jet up to 40 percent more thrust beyond normal Military power (but also burning a lot more fuel in a short amount of time).

AGM Air-to-ground missile (such as the AGM-65 Maverick).

AIM Air intercept missile.

AIM-9 An infrared (heat-seeking) missile.

Aiming Funnel Element of the HUD used in dogfighting mode to aim cannon.

Aiming Reticle Element of the HUD used to indicate optimum targeting for missile fire.

ALQ pod ECM (Electronic Countermeasures) jamming pod.

AMRAAM Advanced medium-range air-to-air missile.

Anchor To stay at a specific point.

Angels Altitude in thousands of feet.

Aspect angle The angle formed between two lines: the line from you to the target and the line running through the axis of the target (from nose to rear).

AVTR Airborne Video Tape Recorder; *see also* ACMI.

Backseater Crew member other than the pilot, in fighter aircraft.

Bail out To eject from aircraft.

Bandit Opponent; enemy.

Bank To roll left or right.

Bent Similar to sick; totally inoperative; a bent aircraft.

BFM Basic fighter maneuver training.

Bingo Fuel state; "If I don't leave I will run out of gas before landing." Also refers to friendly bases in which pilots can refuel—a bingo base.

Birds (Radar term) inconsistent radar return.

Blackout Loss of consciousness from pulling too many positive *G*s (blood leaves your head due to gravity).

Blind No visual contact with friendly; opposite of visual.

Blip A radar image; also called a return.

Block Altitude block; for example 5,000 to 9,000 feet.

Bogey On radar; an unidentified target.

Bogey dope Provided target bearing and range.

Bracket Air maneuver where two aircraft separate to cover both sides of an oncoming bandit.

Break A defensive maneuver where a pursued aircraft turns into the flight path of a pursuing aircraft.

BUFF A B-52.

Bull's-eye Target range and bearing from a specific point.

BVR Beyond visual range.

CAP Combat Air Patrol. Combat Air Patrols fly a specified area looking for bandits.

CAS Close Air Support; missions dedicated to helping friendly ground forces.

CCIP Continuously Computed Impact Point; a HUD element that displays computed impact for free-fall munitions.

Chaff Thin foil strips ejected from an F-16 to confuse enemy radar.

Chattermark Start jamming countermeasures; push to prearranged channel.

Check left/right Turn left/right.

Closure rate The rate at which one plane closes on another. Also referred to as overtake airspeed or smash.

Cludo Clueless.

Clue bag Bag of tricks.

Clueless Befuddled.

Cold mike Microphone off.

Continuous wave radar (CW) Radar that emits a continuous beam of energy.

Contrails Vapor trails left by wing tips in a high *G* turn.

DACT Dissimilar Air Combat Training; aircraft in combat training are different (dissimilar) from each other.

Dog Slow jet; often a two-seater.

Dollarbill game A way of paying for a round of drinks.

Doofor book Semi-official squadron notebook of all the crazy things people have done or said over the years.

Drag Decoy maneuver; an aircraft lures an enemy aircraft across the flight path of another friendly aircraft.

ECM Electronic countermeasures used to fool tracking systems.

Egress To leave a combat area.

Elbow The control zone; area behind a bandit where you can deliver weapons and compensate for any defensive maneuvering; the place to be.

Family model Two-seat fighter.

Finger tip Position on lead; very close, within three to five feet.

Flares Like the flares for your car; they are ejected by your aircraft, burn intensely, and are used to spoof (decoy) enemy IR (infrared) missiles.

Flush Scramble all jets on a ramp (runway).

Fly by Official low-altitude formation flight over a ceremonial gathering.

Friendly A player on your side.

G Gravitational force; 1 *G* is equivalent to normal Earth gravity (which is the *G* environment we all function in normally).

GBU Guided Bomb Unit.

Goat rope A set of procedures that strangles choice and freedom with a bad outcome.

Gomer USAF Aggressor; Navy adversary or bad guy.

Good hands Good job.

Grape Easy target.

GSD Glide Slope Deviation; vertical deviation from the ILS beam (proper landing vector).

Guard Emergency frequency.

Gum shoe *See* Shoe clerk.

Hamfist Poor pilot.

HARM High-speed Anti-Radiation Missile.

Heads up Missed intercept or expected missed intercept because of number of bandits.

Heater Heat-seeking missile.

Heavy Bomber; tanker; transport.

HFR High Fidelity Radar; most true-to-life radar mode in Falcon 3.0; allows you to switch between NAM, SAM, ACM, and STT modes.

Hot mike Microphone on.

Hound dog "I can kill bandit before you"; the engaged fighter.

HUD Heads Up Display.

I'm a dot I'm leaving.

ILS Instrument Landing System; an ILS beam is a radio beacon broadcasting the best landing approach to the runway.

Ingress Entering a combat area.

Inop Inoperative.

INS	Inertial Navigation System; a navigation system that provides you with steering cues to navigation waypoints.
IR	Infrared.
IWC	Instrument weather conditions.
Jink	Violent maneuver to escape.
Joker	Fuel state; a little more than bingo; time to think about going home.
Judy	I have the intercept on radar; stop giving me info.
Kick out	Send wingman out from finger tip to route by kicking rudder; also the call by backseater to change aspect to target.
Knot	Nautical mile (about 6,076 feet).
Lag or **Lag Pursuit**	Nose behind lead aircraft flight path. Your flight path is outside the turning radius of a pursuit aircraft.
Lawn dart	The F-16.
Lead	Flight lead; fighter responsible for flight.
Lead Pursuit	Your flight path is inside the turning radius of a pursuit aircraft.
Localizer Deviation (LD)	Horizontal deviation from the ILS beam.

Mike	AIM-9M heat-seeking missile.
Mort	Friendly kill in ACT; also an inoperative pilot.
Mosam(beak)	Very upset with condition.
Motherhood	Basic support briefing.
Moving earth	Attacking ground targets.
MRM	Medium Range Missile.
NAM	Normal air mode when your HFR is in search mode.
No joy	I do not see the enemy; opposite of tally or tally ho.
Nubie	New guy.
Ops	Operations.
Ordnance	Military weapons.
Overhead open	Visual approaches to airfield authorized.
Padlocked	Maintain visual sighting (locked onto bandit).
Papa	AIM-9P heat-seeking missile.
Patch wearer	Weapons school graduate.
Pickle	Release (usually bomb pickle).
Pig	Slow jet.

Pigeons Point me toward home.

Pincer Attack from both sides of bogey; bracket.

Pitch Altitude- and energy-conserving change in direction.

Pitoui Really bad; spit on it.

Playmate ATC opponent.

Playtime Time in training/combat area.

Poge A nobody; a lieutenant.

Poopy suit Antiexposure suit; waterproof.

Popeye Flying in clouds.

Press Go ahead and attack; I will support you; leave.

Pulse-Doppler radar Radar that emits a pulsed signal.

Punch out Eject from aircraft.

Push Change frequency.

Quibble To make excuses.

Ramp Place to park airplanes.

Ramping down Getting faster; descending.

Red Flag ACT at Nellis AFB, Nevada.

Redout Loss of consciousness due to excessive negative *G*s (too much blood forced into the head).

Reno More than one radar contact; I know which is bogey; no lock.

REO Radar/electro-optical display.

RIO Radar Intercept Officer

ROE Rules of engagement.

RTB Return to base.

Running in Approaching.

SA Situational Awareness; how clued in you are to your surroundings; how well you infer and process information around you.

SAD Situational Awareness Display; a radar mode in which you have full 360° situational awareness; this is one of three radar options in Falcon 3.0.

SAM Surface-to-Air Missile or Situational Awareness Mode. Situational Awareness Mode allows you to monitor other targets while locked on to one target; SAM is selected in Falcon 3.0 in the Configuration screen. SAM is one of three radar modes in Falcon 3.0 (SAD, SAM, and HFR), and is also a suboption of HFR.

S and D Search and destroy.

SCP Stores control panel.

S prefix Weapons school graduate.

Shack Direct hit; exactly right.

Shackle A weave to reposition the flight.

Shoe clerk A non-flyer.

Sick Broken or not working well.

Sidewinder The AIM-9.

SLUFF The A-7.

Snot locker Nose or forward aspect.

Sorted Radar term; I know which bandit is which and am locked.

Sortie A mission.

Sparrow AIM-7, a radar-guided missile carried on the F-15 Eagle.

Speed of heat Very fast.

Speed of snot Very fast.

Speed of stink Very fast.

Spins Special instructions.

Split S An inverted pull down to vertical to reverse direction.

Spread Position on lead; “Spread out 2,000 feet.”

SRM Short-range missile.

Station Time to return to ops desk just prior to flight.

Step Time to leave Life Support (building where flight gear is stored) and go to jet.

Strafe rag Hard wing F-4; unworthy opponent.

Stranger Non-player.

STT Single Target Tracking.

Swine back Two-seat A-4.

Tally or tally ho I see the opponent.

Target arm Weapons school graduate.

Target bearing Angle of the target from you given a course of 0°; if bandit is 10° to your right, your target bearing is 10°; if the target bearing is 350°, the target is 10° to your left.

TD Box Target Designator Box; a display on the HUD that indicates a target, even if that target is BVR.

TDY Temporary Duty.

Tied Radar contact on friendly aircraft.

Training A shop that documents what you have not learned.

Tub A two-seat fighter.

Tumbleweed A jet out of energy, ideas, and optioins.

TWI Threat Warning Indicator.

UPT Undergraduate Pilot Training.

Visual I see you; you are in my flight.

Wall Four lined-up fighters approaching target.

Waypoint Locations of targets in your navigational computer.

Well Fixed.

Whiteout Early stage of blackout where you lose ability to distinguish color.

Winchester Out of ordnance; only rounds remain.

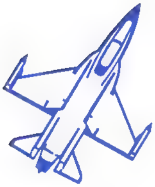
Wing Flight follower; non-leader.

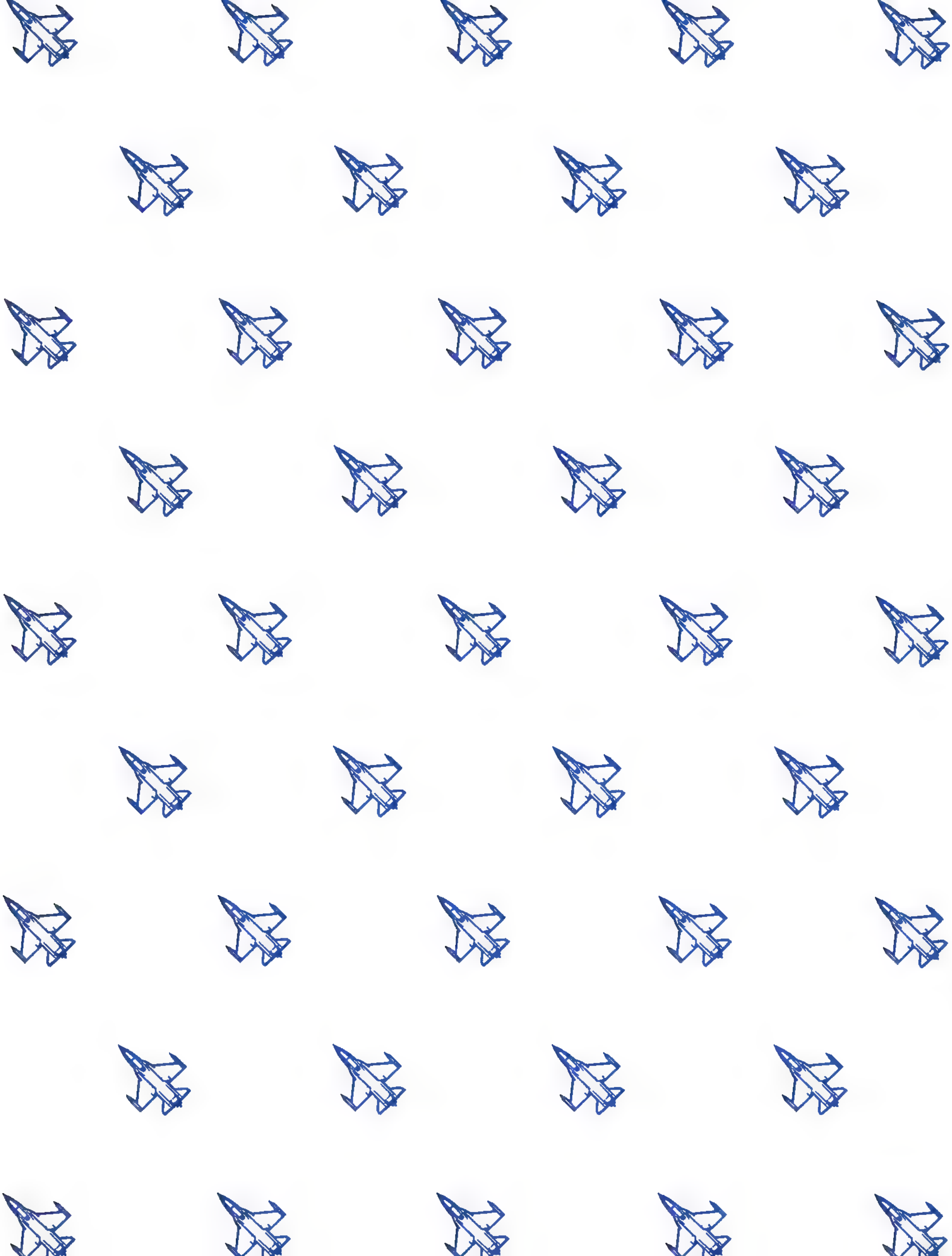
Wingie Pilot not yet qualified as flight leader.

WSO Weapons Systems Officer.

Zoo USAF Academy.

Zoomie Air Force Academy graduate.





APPENDIX

F

FALCON 3.0 CAMPAIGNS

Many different air and ground forces are involved in Falcon 3.0 campaigns, all with a common objective that is stated in the beginning of the campaign. Your F-16 squadron is but one element; each side in the conflict has a vast amount of troops, equipment, armament, and supplies. However, as Squadron Commander, always remember that your squadron is the most important element in the entire war. With excellent leadership on your part, your squadron could be responsible for achieving allied success in the campaign. Your pilots, aircraft, and support staff are the best in the business, but it's up to you to lead your forces to victory.

How a Campaign Works

At the start of each campaign, Falcon 3.0 randomly chooses one of three strategies for each side. These strategies determine the way the campaign will be fought. Falcon assigns each side certain *victory nodes* that it must defend or attain in order to win. In addition, each side is assigned an *offensive value* (somewhat arbitrarily) that determines how aggressive the side will be in pursuing its objectives. Falcon stores each victory node in order of importance and examines this list each "day" of the campaign to find the first site that is controlled by enemy forces. This site becomes the active victory node.

Determining Mission Type

Falcon 3.0 sends your squadron on four missions per campaign day. Falcon determines these missions by using a combination of random and campaign-dependent factors. For example, if there are any enemy airfields still active, Falcon 3.0 will randomly choose one of a number of *air superiority* types of missions. In such case your squadron may be assigned to escort B-52s to destroy an airfield, to bomb that airfield itself, or to fly into enemy territory to take out any aircraft you can find.

Determining Mission Location

Once Falcon 3.0 determines a mission type, it sets the location for that mission based on the current state of the campaign. For example, a *ground strike* mission takes place near the front line at the node nearest the currently active victory node, while a *close air support* mission takes place at the enemy node closest to your current base. (Nodes are explained in the next section.)

Occupation Map and Nodes

Each campaign theater is divided into a number of strategic sites called *nodes*. (There are about 80 nodes in each theater.) Nodes may be airfields, cities, troop staging areas, bridges, and other important positions. You can see all of the nodes by clicking on the Tact/Strat button at the bottom of the Red Flag screen.

At the beginning of a campaign, Central Command (CentCom) determines which nodes you must control in order to collapse the enemy's war machine. Of course, at the same time, the enemy is trying to control nodes in order to collapse *your* war machine. Throughout the war, CentCom will send your squadron to various hotspots, and you will put out the fires.

You and the enemy meet head-on at the front line, and it is usually a hotbed of activity. You can expect Central Command to send you on missions to the front on a more than occasional basis. *All* nodes are captured and lost on the front line, although nodes can be attacked by air forces outside the front line.

Color Coding for Nodes

Ground forces may take various routes from node to node, and each node is connected to at least one other node by these routes. Also, each node is color-coded: enemy-controlled nodes are red and ally-controlled nodes are blue. The front line is where red and blue nodes meet. The Occupation map (on the

Debriefing screen and the Report screen) shows color-coded rings around the nodes to denote the territory controlled by each side, and lists the percentages of territory controlled. The rings are darker where they overlap, to represent areas of combat.

Color Coding for Ground Forces

Ground units are also color-coded: allied ground forces are green or gray and enemy ground forces are brown.

Missions

There are three types of missions you may lead: offensive, defensive, and front line.

Offensive Missions

CentCom will send you on offensive missions to attack sites within enemy territory. Offensive missions generally consist of flying bombing runs or escorts.

Defensive Missions

When the enemy sends aircraft or troops to attack one of your key sites, you end up on a defensive mission. Defensive missions are primarily CAP (Combat Air Patrol), scramble, and screen missions. Scramble missions will come up on your Report screen when you're about to be attacked. You'll need to move (scramble) your aircraft to be victorious. Screen missions are missions to the front line.

Front Line Missions

Front line missions occur on the main battlefield—where ground troop combat occurs—and are mainly CAS (Close Air Support), ground strike, and air superiority missions.

Victory Conditions

There are three interrelated factors that determine whether you win the war: individual mission completion, daily mission success, and campaign victory. In a campaign, the most important factor is to win three of the four daily missions.

Individual Mission Completion

Falcon 3.0 lists descriptions of each of the four missions you will fly in one day of a campaign on the Briefing screen. Each time you cycle into the Briefing screen, you will be given another of the four missions. The descriptions include specific objectives that you must achieve in order for your mission to be counted as a success. Failure in *any* area of the mission description on the Briefing screen is tallied as a mission failure.

The parameters for success in individual missions are listed in the following sections. There are ten specific types of missions CentCom may send you on. The Report screen contains a list of these mission types. In addition, you can tell what the mission type is by *key words* in the mission descriptions on the Briefing screen. The next sections use the Report screen name for each mission type. The key words to look for on the Briefing screen are included in parentheses after the Report screen name.

Air Superiority (deny enemy air activity)

Your flight must destroy at least three enemy aircraft along your flight route.

Bomb ("name of target")

Your flight must destroy the target as selected by using the Target button on the Edit Waypoints screen.

Close Air Support (command ALO has requested TAC AIR)

Enemy losses (ground units of any sort) must be greater than allied losses in the target area.

Combat Air Patrol (fly CAP over area)

Your flight must destroy any incoming enemy aircraft; these generally will be fighter or strike aircraft.

Escort Bombers (escort B-52s) Your aircraft must reach the B-52s' target area. (Oddly enough, you do not have to reach it along with the B-52s.)

Escort Strike Aircraft (escort strike aircraft) All additional strike aircraft must be functional and operational at the end of the mission.

Escort Transports (milk run) Both transports (C-130s) must be functional and operational at the end of the mission.

Ground Strike ("name of target" or armed reconnaissance) Your flight must destroy more than seven ground units in the area of conflict; any targets on the way to the conflict area are fair game.

Scramble ("list of incoming aircraft") There are three conditions that must be met for a successful scramble mission:

- Your flight must destroy at least three enemy aircraft.
- No more than seven allied ground units may be destroyed.
- All enemy bombers must be kept out of your home airbase.

Daily Mission Success

At the beginning of a campaign, Falcon 3.0 assigns each side an initial offensive strength, which is used to determine how aggressive each side is in waging war at the beginning of the campaign. This decision is made somewhat randomly, based upon several predetermined possibilities. Falcon 3.0 checks each side's offensive strength at the end of each campaign day; a decision to attack or sit tight is made based on that side's offensive strength. For example, in the Kuwait campaign, the Iraqis have a very low offensive strength, while the allies have a relatively high one. If you lose every mission, it may take a few days before the Iraqis start to make any gains on you, but they are likely to eventually.

The success or failure of your squadron has a direct effect on your side's offensive strength. If you successfully complete more than half (three or four) of your missions in any given campaign day, the allies' offensive strength increases; if you complete only one or two missions, the allies' offensive strength decreases.

The effect of one day's failed missions on the whole war depends upon the relative strength of each side. For example, if the enemy's strength is very low and the allies' very high, the likelihood of one day's failed missions turning the tide of the war is much lower than if the two sides' strengths were even at that time.

Campaign Victory

Before a campaign begins, Falcon 3.0 determines a set of victory conditions for each side that, once achieved, will win the war for that side. Throughout the campaign, each side attempts to control these *victory nodes*.

At the end of every campaign day, Falcon 3.0 checks the state of the campaign to determine if the end of the war has occurred. (After 14 days, Falcon 3.0 will automatically end the war and determine the winner as indicated in the next sections.) There are three possible outcomes for each campaign: victory, defeat, and stalemate. To determine the final outcome, each side's victory nodes are tallied at the end of the war. The outcome is determined by the percentage of victory nodes controlled by each side, as described in the following sections.

Victory

If the allies control 70 percent of their victory nodes, they have won the war.

Defeat

The enemy has won if they control 70 percent of their victory nodes. Additionally, if at any time during a campaign you have no airbases from which you can launch your F-16s, your side (the allies) automatically loses the war.

Stalemate If neither side has control of 70 percent of its victory nodes, the war is considered a stalemate and both sides head to the bargaining table.

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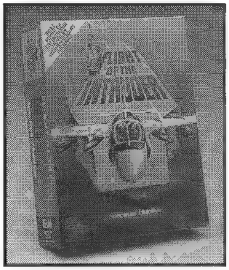

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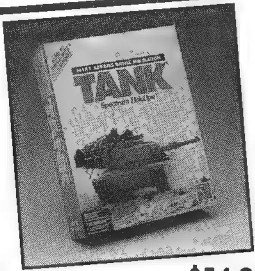

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Flat shading
Gouraud shading
Lighting:
Linear fog
Exponential Fog

support 1 million polygons, where the Cobra is just being learned to program on and it reaches more than 1 million—first try!

Aristo tries to succeed with a simple plan: a Global Party

"Aristo International designs and develops location-based, pay-per-play,

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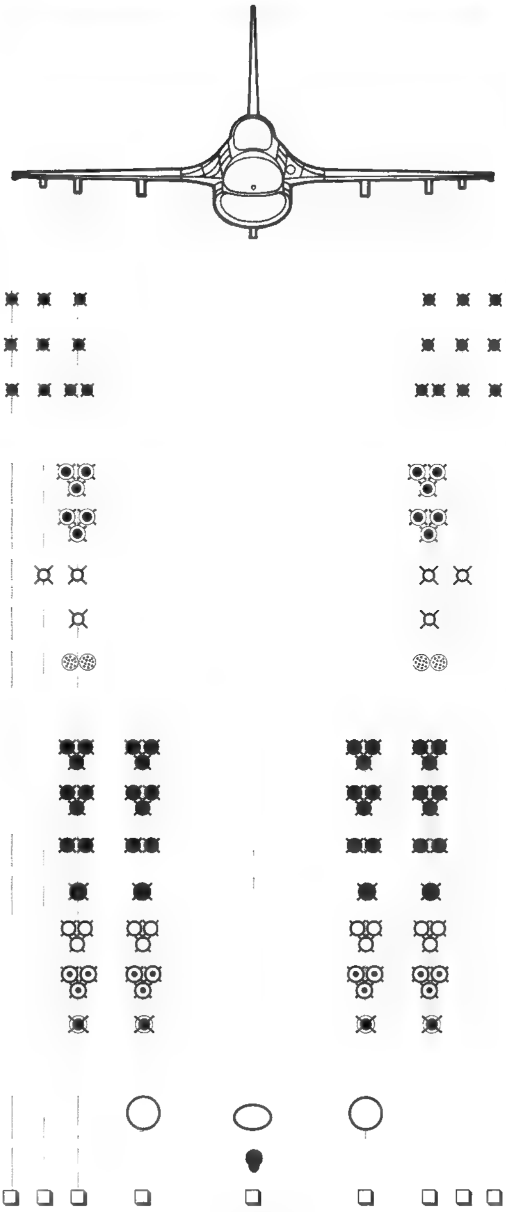
Board ... support 1 million polygons, where the Cobra is just being learned to program on and it reaches more than 1 million—first try!

FALCON 3.0

ARMAMENT CONFIGURATION

AIR-TO-AIR MISSILES	LOAD	PER PYLON /MAX
AIM-9P Sidewinder	☐	1/6
AIM-9M Sidewinder	☐	1/6
AIM-120 AMRAAM	☐	1 or 2/8
AIR-TO-GROUND MISSILES		
AGM-65B Maverick	☐	3/6
AGM-65D Maverick	☐	3/6
AGM-45A Shrike	☐	1/4
AGM-88A HARM	☐	1/2
LAU 5003-A Rocket Launcher	☐	2/4
AIR-TO-GROUND BOMBS		
Mk82 - 500lb	☐	6/24
Mk82HD Snakeye - 500lb	☐	6/24
Mk83 - 1000lb	☐	2/8
Mk84 - 2000lb	☐	1/4
BLU-107/B Durandal	☐	3/12
CBU-84 Cluster Bomb Unit	☐	4/16
GBU-15 Guided Bomb Unit	☐	1/4
OTHER STORES		
Fuel Tank	☐	1/3
ALQ-131 ECM Pod	☐	1/1



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OTHER CONTROLS

COMM. MODE

`	Chat
Alt A	Abort
Alt Q	End

VIEW

Ctrl + Other keys to fine tune rotation movements

GM (GROUND MODE) RADAR ZOOM RECTANGLE CONTROLS

⇧ Shift + ↑ ← ↓ → Move rectangle up, down, left, right

F1	Zoom In
F2	Zoom Out

MAP CONTROL KEYS

↑ ← ↓ →	Move cursor
Right ⇧ Shift + ↑ ← ↓ →	Scroll Map
Left ⇧ Shift + ↑ ← ↓ →	Drag Waypoint
+	Zoom In
−	Zoom Out

MISC.

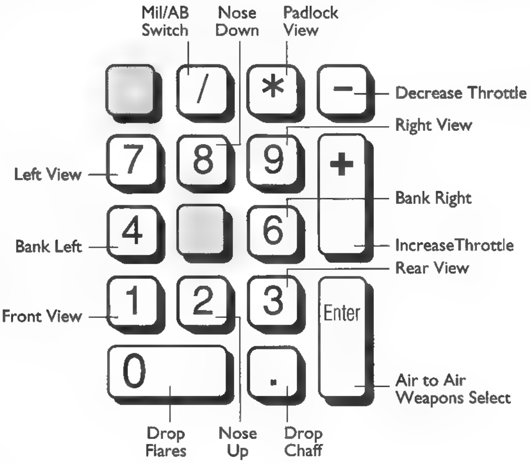
Alt X Exit to DOS

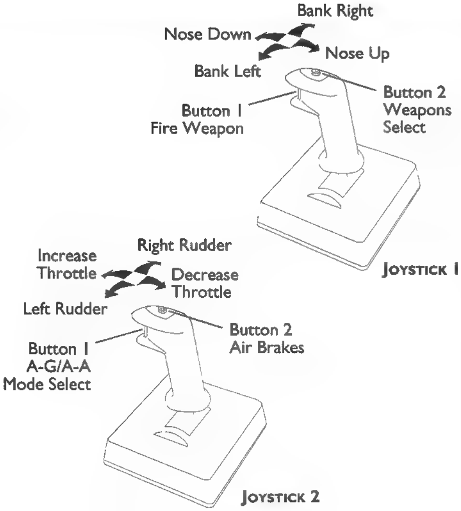
UNDOCUMENTED CONTROLS

Enter this mode by pressing P, *followed by* Tab ⇥ *anytime during flight. Resume with* P.

↑ ← ↓ →	Move forward, backward, left, right
Pg Up	Increase Altitude
Pg Dn	Decrease Altitude
F3	Rotate Right
F4	Rotate Left
⇧ Shift F3	Rotate Up
⇧ Shift F4	Rotate Down
Ctrl	+ Rotation Keys above to fine tune rotation
+	Increase Movement Factor
−	Decrease Movement Factor
D	Debug Mode — Displays coordinates and frame rate
T	Enter Coordinates to Transport to
⇧ Shift T	Change Time of Day

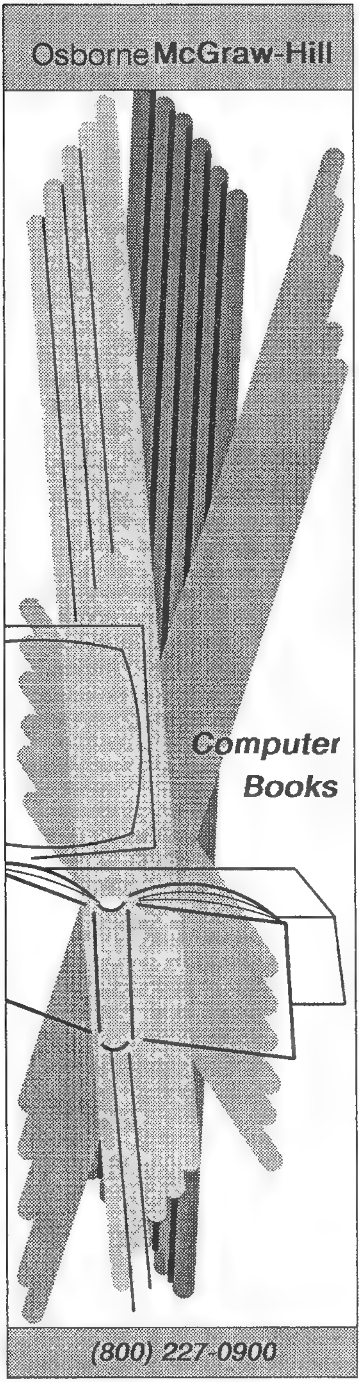
NUMERIC KEYPAD & JOYSTICK CONTROLS





JOYSTICK 1

JOYSTICK 2



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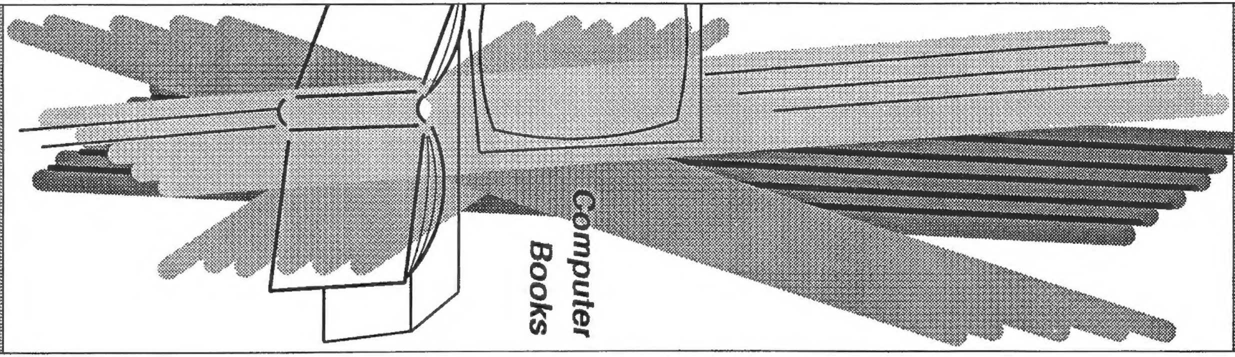

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